PUBLIC DOCUMENT..... .....No. 30.

NINTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

JANUARY, 1878.

BOSTON:
Rand, Avery, & Co., Printers to the Commonwealth,
117 Franklin Street.
1878.

MEMBERS OF THE BOARD.

HENRY I. BOWDITCH, M.D. . .	OF BOSTON, *Chairman.*
ROBERT T. DAVIS, M.D. . . .	OF FALL RIVER.
RICHARD FROTHINGHAM . . .	OF BOSTON.
JOHN C. HOADLEY, C.E. . . .	OF LAWRENCE.
DAVID L. WEBSTER	OF BOSTON.
THOMAS B. NEWHALL . . .	OF LYNN.
CHARLES F. FOLSOM, M.D. . .	OF BOSTON, *Secretary.*

CONTENTS.

GENERAL REPORT OF THE BOARD.

State Board of Health, State House,
March, 1878.

To the Honorable the Senate and the House of Representatives of Massachusetts.

The State Board of Health herewith respectfully present their Ninth Annual Report.

The Law concerning Slaughter-Houses and Noxious and Offensive Trades.

The Brighton Abattoir, now for two years in charge of the Board of Health of Boston, continues to be satisfactorily managed, having facilities for slaughtering seven-eighths of the cattle needed in the metropolitan district, and for disposing of the various kinds of offal, &c., necessarily connected with business of that kind, in a manner inoffensive and without injury to health. A brief description of the more important processes, taken from a small pamphlet sent by the Board to the Paris Exposition, with plans of the abattoir, may be of interest, as indicating what has been accomplished, and as being, to a certain extent, a guide to local authorities throughout the State, by showing the principles of dealing with slaughtering-establishments, large and small, in the various cities and towns.

For convenience in caring for the blood and offal, the plan of slaughtering on a raised floor, above a basement story, was adopted. This floor is of double plank, calked, and well laid on beams, with a slope to an iron gutter running across the centre of the floor, which receives the blood, and conveys it to iron wagons in the basement, which has a floor of asphalt. Several trap-doors in the floors of the slaughter-houses receive the heads and feet, hide, tallow, and offal, each dropping into separate iron wagons below. The various wagons, as often as filled, are wheeled into the render-

ing-house ; the hides being salted in the basement, and the blood, offal, heads, fat, and tallow being raised to the rendering-tanks and driers by means of elevators.

In most of the buildings, the cattle are hoisted for dressing, by steam-power, through shafting connected with the engine in the rendering-house, to which the necessary pulleys are attached; although in some of the buildings the old method of hoisting by hand, with the wheel and rope, is still carried on.

Hot and cold water are supplied to each slaughter-house, and the floor and walls of each house are thoroughly washed at the close of each day's killing. The water, in abundance, is the only disinfectant used, even in hot weather.

Connected with each house is a refrigerator, in which all cattle are placed after having been dressed. They are allowed to remain from several days to a couple of weeks before sending to market. These refrigerators vary in their capacity ; those attached to the smaller houses furnishing space to hang sixty cattle, while in some of the larger houses as many as two hundred can easily be stored. The arrangements for slaughtering sheep and disposing of the blood and offal are substantially the same as above described for cattle.

In the rendering-house are placed, in the fifth story, two large iron water-tanks, each holding about fifty-eight thousand gallons. These tanks are filled by steam-pumps in the engine-room, and are connected by distributing-pipes with nearly all the buildings and yards on the premises ; also with several hydrants, for use in case of fire. The rendering-tanks are suspended from the floor of the fourth story, and are filled from that story with the offal, heads, and tallow contained in the small iron wagons coming from the basements of the slaughter-houses. Different tanks are used for the various processes of making tallow, fertilizers, &c. After the contents of the rendering-tanks are sufficiently cooked, the fat is drawn off and packed. The residuum from the tanks in which bones and intestines are cooked, the scraps, or what remains after being pressed, are put into the driers, which are located in the second story, but are filled through pipes leading into them from the third-story floor. The blood is also put into the driers here, after having been partly dried in the tanks. The contents of the driers are subjected to steam-heat, by means of revolving sets of steam-pipes inside of them, for several hours, until the water has been sufficiently evaporated ; when they are discharged upon the second-story floor, and after being passed through a mill, to grind any particles of bone that may not have become sufficiently fine in the process of cooking, are disposed of as a fertilizer. This fer-

tilizer is made by mixing together the dried products of rendering the bones, intestines, and blood. In the large building in the process of construction, sulphuric acid and other chemicals are to be added, in varying proportions, to be adapted to the needs of various crops, and to suit the demands of different soils.

The feet are cooked in the third story, to extract the neat's-foot oil from them; and the tallow, grease, oil, shin-bones, and hoofs are stored in various parts of this building.

The steam and offensive gases from the rendering-tanks and driers are received into a large iron vessel, through which cold water is continually passing, where the steam is condensed: the offensive gases pass on into a large pipe, from which they are drawn by a fan. The aqueous vapor having been condensed and left behind, the gases are mixed with large volumes of air by means of a patent blower, and then pass under the furnace fires to be consumed. The furnaces are so arranged, that when the fire is low, or when fresh coal is added in any one, the gases can be directed under another furnace where the fire is burning briskly, so that complete combustion is always accomplished; and there are no offensive odors at any time, although such a large mass of animal matter is constantly treated day and night.

The tanks in which the offal is cooked for a varying number of hours, depending upon its character and use, have at the end of that process a certain amount of water in them, containing in solution and in suspension a certain amount of gelatine. This is called soup; and that which comes from boiling the heads and the feet is still further boiled down for the purpose of making glue, which finds a ready sale in the market; the rest of the soup is thrown away.

The best portions of the fat are tried out for making artificial butter. The shin-bones are sold for knife-handles, &c. The hoofs are manufactured into various articles of use and ornament. The offal removed from the stomach and intestines is carted away from time to time, to be used as manure.

All offal and blood are rendered and dried immediately while fresh and untainted. The plan of elevating the slaughtering-rooms, so that all blood, offal, &c., may be dropped into the wagons in the basements, renders the labor of keeping those rooms clean comparatively easy. This, as well as the system of receiving the products of slaughtering in iron wagons, and raising them on elevators to the tanks and driers, has proved very satisfactory.

The method adopted for the destruction of the gases after rendering prevents any offensive odors arising therefrom. It requires and receives constant and careful attention by day and night; and

the experience of the past four years and a half has proved the possibility of carrying on a large slaughtering and rendering establishment without offence or annoyance to the community around it.

During this time there have been slaughtered 282,857 cattle and 1,321,573 sheep, an average of nearly 63,000 cattle and 294,000 sheep each year. The fertilizer, manufactured from the blood and offal from this slaughtering, has ranged from 1,200 to 1,500 tons a year. The expense incurred for the purchase and preparation of land, for erecting buildings, and for providing machinery necessary to carry on the business, has been about $630,000.

There are, near Boston, rendering-establishments for disposing of grease, tallow, &c., which, not being furnished with suitable appliances, are sources of serious offence. There is still some representation to the Board, from time to time, that there are offensive smells from the Miller's River district, partly due, doubtless, to the exposed sewer-outlet under Craigie's Bridge, at low tide. The rendering-establishments in that neighborhood, however, require proper inspection, in justice to those who are not reasonably to be complained of.

Proper appliances should be insisted upon where any can be used satisfactorily to avoid creating a nuisance, and such as cannot conduct their business without causing noxious stenches should be removed beyond the city limits. It is hoped that the newly-appointed Boards of Health of Cambridge and Somerville may be enabled to meet, for their cities at least, this want so long felt by a large community.

In the case of *The Selectmen of Watertown v. George A. Sawyer*,[1] the Board ordered, April, 1876, that the defendant be ordered to cease and desist from the business of slaughtering sheep in the premises then occupied by him, on and after May 15, 1876. The same party had been complained of to the Board several years previously; and, after a hearing, it was understood that he might go on with his business, provided he introduced certain means of cleanliness suggested by the Board, which, however, he neglected to do. At the time of the second complaint, he also refused to improve his method of conducting his business; and the Board

[1] Compare the Eighth Annual Report of the Board, p. 5.

adjudged that it was too offensive to be allowed to continue. The case was appealed to the Superior Court, who decided that they had no jurisdiction under the law; when it was referred to the full bench of the Supreme Court for their opinion. After full consideration, they decided that, although there was no power of appeal expressed in the law regarding noxious and offensive trades, yet that such was its intent. The case came up again, therefore, before the Superior Court, as a result of which the jury were equally divided in regard to sustaining the decision of the Board, but finally agreed to allow the defendant to continue his occupation, provided he carried it on with improvements essentially the same as those already suggested to him by the State Board of Health, and provided he conducted his business in a manner satisfactory to the local Board of Health. From this decision the case was carried again to the Supreme Court under several exceptions; but the defendant still obeys the order to cease and desist.

In the case of *Keith et al v. Messrs. Lawton, Andrews, & Brown*, of Bridgewater, in which the Board deferred action in order to arrange a compromise,[1] if possible, the order to cease and desist was passed April 3, 1877, to take effect May 1. The selectmen of the town, however, acting as a local board of health, gave sufficient assurance that they would properly regulate the business; and the above order was revoked Sept. 6.

July 7, 1877, the Board heard the case of *Mr. H. Vandine and twenty-five others, v. Messrs. E. H. and C. E. Norton*, soap-manufacturers in Cambridge. It was adjudged that the business of boiling fat and bones was offensive and noxious; and, after giving the defendants abundant time to remedy the evils complained of (if that were possible), the Board ordered them, Jan. 10, 1878, to cease and desist, on and after March 1, 1878, from the business of rendering fat, grease, meat, and bones. The manufacture of soap was not included in the order.

A complaint was also made by many of the same complainants as in the previous case, against the rendering-establishment of *Messrs. Dow and Reardon;* but it was afterwards withdrawn, because it was so far distant from their houses,

[1] See the Eighth Report, p. 6.

and because improved methods of conducting the work were in active progress.

Sept. 7, 1877, the Board heard the case of *Donald McIntire, and one hundred and ninety others, v. Messrs. Mason Davis and Son.* It was alleged, and adjudged by the Board to be proven, that the premises were noxious and offensive, although the parties complained of were responsible for only occasional foul stenches; and the defendants were ordered to cease and desist from the business of rendering house-grease, &c., on and after Sept. 30, 1877. It appeared at the hearing, that another party, *Mr. Henry James*, although not included in the formal complaint, conducted the greater part of the offensive business at the place in question. A petition was therefore, several months later, sent to the Board by Mr. Fatal and twenty-four others, requesting him to be ordered to cease and desist. After a hearing of both parties, Mr. James was ordered to cease and desist on and after March 1, 1878.

Oct. 12 and Dec. 31, 1877, and Jan. 2, 1878, the Board heard the case of *one hundred and eighty-six petitioners v. The Bradley Fertilizer Company*, whose works for making a fertilizer from bone phosphate, acid, dead fish, &c., are situated in the town of Weymouth. It appeared that the only complaints to the Board were from persons living in or near the village of Hull, and others passing up and down the harbor in steamers. The towns of Hingham and Weymouth had been protected to their satisfaction, by careful attention to the direction of the wind when the most offensive odors were escaping. The premises were twice visited by the members of the Board; the Secretary has, in addition, inspected them in company with Dr. S. H. Durgin, Chairman of the Boston Board of Health, and again with Professors E. S. Wood and H. B. Hill, who made some chemical determinations with reference to discovering some means of abating the difficulty. The Board have reserved their judgment for the present, to allow time for improved methods of conducting the business to such a degree as to satisfy the petitioners.

A slaughter-house was complained of in Woburn; but no hearing was held, from want of proper formality in the petition. The owner stated that he should soon discontinue the business, and so no further action was taken by the petition-

ers. In several other cases it is thought that the advice of the Board has been followed so far as to cause the abatement of nuisances without the necessity of formal hearings and orders.

Vital Statistics.

The Joint Committee of the Legislature on Education have proposed a bill, as recommended by the majority report of the Board of Supervisors of Statistics, the essential feature of which is the establishment of a permanent board of statistics.

The Board just referred to have also unanimously recommended a bill, which, as amended, is as follows: —

A Bill to Provide for the More Accurate Registration of Vital Statistics.

Be it enacted, &c.,

Section 1. No human body shall be buried, or removed from any city or town, until a proper certificate has been given by the clerk or local registrar of statistics, to the undertaker or sexton, or person performing the burial, or removing the body. This certificate shall state that the facts required by chapter twenty-one of the General Statutes have been returned and recorded; and no clerk or local registrar shall give such certificate or burial permit until the certificate of the cause of death has been obtained from the physician last in attendance, and placed in the hands of said clerk or local registrar: *provided* that, in those cities and towns where local boards of health have been established, the certificates of deaths shall be approved by such board before a permit to bury is given by the registrar or clerk.

Upon application, the chairman of the local board of health, or any physician employed by any city or town for such purpose, shall sign the certificate of the cause of death to the best of his knowledge and belief, if there has been no physician in attendance. He shall also sign such certificate, upon application, in case of death by dangerous contagious disease, or in any other event when the certificate of the attending physician cannot, for good and sufficient reasons, be early enough obtained.

In case of death by violence, the medical examiner attending shall furnish the requisite medical certificate.

Any person violating the provisions of this section shall be punished by a fine not exceeding twenty-five dollars.

Sect. 2. This act shall take effect on first day of May, eighteen hundred and seventy-eight; and all acts and parts of acts inconsistent herewith are hereby repealed.

Both of these measures seem to us of such great importance, and evidence is so continuously accumulating to show how much our registration of vital statistics needs improvement, that we most earnestly and respectfully desire to add our recommendation of the general methods which have been suggested for accomplishing so desirable an object.

Boards of Health.

Under the new law authorizing the appointment of independent boards of health in the cities of the State, if the voters should so decide at the November election, the votes cast on that subject were as follows: —

City.	Population, by census of 1875.	Yea.	Nay.
Cambridge,	47,838	2,003	468
Lowell,	49,688	983	335
Worcester,	49,317	707	20
New Bedford,	25,895	304	267
Newburyport,	13,323	231	86
Lawrence,	34,916	253	152
Somerville,	21,868	267	178
Fall River,	45,340	174	52
Fitchburg,	12,289	118	648
Gloucester,	16,754	629	819
Newton,	16,105	545	779
Lynn,	32,600	312	739
Chelsea,	20,737	296	305

In Haverhill, Holyoke, Salem, Springfield, and Taunton, no votes were cast under the law. The lack of interest which has been shown in the matter was rather surprising.

It is very much to be desired that the boards of health of towns should be better organized; and to that effect we would respectfully recommend that they be composed of the chairman of the board of selectmen, one physician, and one other citizen not connected with the town government.

With the object of bringing the State Board of Health in more direct relation with the local boards throughout the State, the following circular has been sent to each city and town in the State.

State House, March 1, 1878.

To the Boards of Health in the State.

Gentlemen: The State Board of Health are desirous of increasing their usefulness, and of extending their means of obser-

vation, by placing themselves in more direct relations with the local boards of health. To that end, circulars will be addressed from time to time, to the various boards throughout the State, containing matters of interest regarding the public health. The Board will also be very glad to receive suggestions in regard to any subjects affecting the health of the community, and information with regard to the prevalence of epidemics, influences injurious to health, subjects for investigation, &c. At the close of each year, and, after this year, at the close of each quarter, they will ask for reports concerning the actions of the boards, and the health, &c., of each town, for that period. At the same time, they desire to be informed promptly of the presence of dangerous epidemics or matters requiring investigation by the Board.

On the first Tuesday of each January, April, July, and October, the Board hold their quarterly meetings, at which they will always be glad to see any members of local boards of health who desire to confer with them.

The Board will be pleased to receive communications through their Secretary, at all times, either personally or by letter, upon any subjects with regard to which local boards desire to make inquiries, or to avail themselves of the experience of the State Board of Health.

We have the honor to be,

Very respectfully yours,

Henry I. Bowditch,
Robert T. Davis,
Richard Frothingham,
David L. Webster,
John C. Hoadley,
Thomas B. Newhall,
Charles F. Folsom,
Members of the State Board of Health.

Drainage, Sewerage, and the Pollution of Streams.

The investigations with regard to the above important subjects have been continued during this, the third, year. From the evidence presented in this and the previous reports of the Board, it is clear that there are some places in the State where harm is already done by the pollution of water-courses, although not to that extent which may commonly be seen in England, for instance. It appears, too, that there are many places where proper care may prevent the extension of lesser evils, which now appear to threaten to do harm in the future,

unless checked, but that, as a whole, throughout the State, the evil from the pollution of streams is small as compared with that arising from the accumulation of filth in privies, cesspools, &c., near dwellings, thereby contaminating the air and the water taken into the human system.

It has been clearly shown by the investigations of the Board, that a dangerous amount of pollution may exist in drinking-water, without its presence being revealed in any way to even the practised sense, unaided by chemical examination. The organic material which conveys disease, however, cannot be detected by the chemist, and is probably associated with, rather than a necessary part of, the impurities which he finds.

In a similar way, the contaminated soil sends forth exhalations into the air, which are no less dangerous and much less easily recognized. In both cases, the chance of getting into the system any poison which conveys disease depends upon its dilution and upon various other contingencies, which, in the present state of science, are chiefly matters of speculation. But that there is a risk, and a great one, in breathing polluted air or in drinking polluted water, is a fact now so well known that there is no maxim of sanitary law which is better established.

With regard to the relation between bad drainage and the diphtheria which has been so prevalent in the State, it certainly cannot be said to have prevailed entirely in proportion to the filth, or in proportion to the soil-moisture, or in proportion to the two combined. But there are many good reasons for thinking that the disease, like typhoid-fever, is propagated more readily under a certain relative combination of the two conditions, although the chief elements in its origin are almost, if not quite, unknown. The upholders of all the theories meet on this common ground: that filth and moisture constitute an important link in the causation of disease, — a link more easily broken, too, from the fact that it is known and accessible.

The most economical method of remedying soil-pollution may not lie in the immediate introduction of sewerage, but that is certainly the best way; and a considerable increase in the pollution of some of our rivers, if that is necessary, would be a much less evil than those now existing of unre-

moved filth. Good sewerage, too, would very much improve the defective subsoil drainage of many towns.

In certain cases, too, nothing can be better, under the circumstances, than some method of disinfection of fæcal matter with dry earth, and its frequent removal to a sufficient distance, before it can cause serious contamination of the soil or air.

In order to encourage towns, however, to make the greatest possible sanitary improvements, no unnecessary expenditure of money must be thrown in their way, at the same time that harmful pollution of streams must be prevented; and it will therefore be necessary to regulate, rather than wholly prohibit, the contamination by filth of our waters.

It would be unwise, also, to place too great restrictions upon manufacturers by setting up, for all cases, some arbitrary standard of purity, which it would not be possible, in many cases, to enforce. In regard to this most interesting question (as to the means of preventing or remedying the pollution of streams), the whole number of replies to our circulars of inquiry sent to manufacturers have been tabulated, with the following results: —

Forty-two (42) fail to answer that question at all.

Twenty-five (25) are unprepared to give any opinion.

Four (4) think that nothing is needed in their special localities.

Sixteen (16) think that, taking all things into consideration, nothing is better (and at the same time practicable) than allowing the filth to run off by the streams.

Thirty-eight (38) think that some remedy, complete or partial, is practicable; and, of these, all but six suggest in a general way what that remedy should be.

The draft of the bill[1] to prevent the pollution of streams and for other purposes, as proposed by the Board, provides: —

I. That no solid refuse be cast into ponds or streams so as to interfere with their flow or pollute their waters, except for the sake of wholly or partly filling them for proper purposes.

II. That water-supplies shall not be further contaminated.

III. Power of local boards of health, with the approval of

[1] See page 73.

a properly constituted board, to regulate the pollution of streams not used as water-supplies.

IV. Regulation of the discharge of various substances into sewers; the approval of the board above referred to, before water-supplies or sewers can be introduced; prohibition of building or raising dams without the permission of the same board; abolition of privies and cesspools within proper limits.

V. Prohibition of direct discharge from privies, of human excrement, into streams.

VI. Power of the board already mentioned, to abate any existing evils in the matter of pollution of streams, when in their judgment the public health or the public comfort and convenience shall require, either by an order to "cease and desist," or by requirement that the noxious matter be purified or sufficiently cleansed: *provided*, that, on any application to the board to exercise the powers conferred upon them, a time and place for hearing the parties shall be assigned, and due notice thereof given to the party against whom the application is made. In all such cases the board are to consider the reasonable practicability of a remedy, as an important element in rendering their judgment.

VII. Supervision and partial control by the State Board of Health, of the drainage, sewerage, and disposal of sewage of the State institutions, — a matter in which a beginning has already been made in the passage of the following act: —

An Act concerning the Sewage of the State Prison in the Town of Concord.

Be it enacted, &c., as follows:

Section 1. The Warden and Board of Inspectors of the State Prison, in the town of Concord, are hereby prohibited from causing or permitting the discharge, through any sewer or drain, of any portion of the sewage of said prison into the Concord River or any of its tributaries, unless said sewage shall have been purified or cleansed in a manner satisfactory to the State Board of Health.

Sect. 2. This act shall take effect on its passage.

Approved Feb. 13, 1878.

There are a few points to be borne in mind with reference to water-supply, drainage of houses, and sewerage, which

have been suggested by the examinations of the Board in this State, and may properly be summarized here: —

I. The privy system, so common throughout the State, by which filth is stored up to pollute the air, soil, and water, near dwellings, should be in all cases abolished.

II. Cesspools, unless with extraordinary precautions as to ventilation, and prevention of pollution of soil and air, are little better, and should be given up for something less objectionable as soon as practicable.

III. Wells cannot be depended upon for supplies of wholesome water, unless they are thoroughly guarded from sources of surface and subsoil pollution. Some of the foulest well-water examined by the Board has been clear, sparkling, and of not unpleasant taste.

IV. Where wells have already become polluted, and it is not practicable to dig new deep wells remote from sources of contamination, or to introduce pure public water-supplies, the storage of rain-water, properly filtered, is a satisfactory method of procedure.

V. In small towns where public water-supplies have not been introduced, and, indeed, wherever water-closets are not used, some method of frequent removal and disinfection with earth or ashes[1] should be adopted in place of privies, by which it should be impossible for the filth to soak into the soil, or escape into the air. Cemented vaults are not always to be depended upon, as their walls crack from frost or through settling of the ground; and they thus sometimes become sources of pollution of wells, beside contaminating the air. Nor is the fact of a privy being on a downward slope from the well a sufficient safeguard; for even then the direction of the subsoil drainage may be toward the well.

VI. Earth-closets, *with proper care*, may be satisfactorily adopted. But the earth, after having been once used, should be placed upon the land, not stored within doors and dried to be again used; for, in the process of drying, there are emanations from it which are perhaps not less dangerous from the fact of their being imperceptible by the unaided

[1] There are several methods of accomplishing this object, as described in the Seventh Report of the Board. Galvanized-iron pails, with a free use of dry earth, and frequently emptied, as shown on page 185 of that Report, are among the best.

senses, or through chemical examination. With earth-closets, a plan similar to that in use at the Pittsfield Hospital [1] may be well used for the chamber-slops; and the kitchen waste may be utilized (with the chamber-slops, too, if desired) in the manner [2] used by Mr. Field and Col. Waring. Less intricate methods are used in scattered dwellings, but with the effect of having the slop-water absorbed by the ground, and taken up by vegetation so far from the house as not to involve a nuisance or danger to health.

VII. Where water-supplies, water-closets, &c., are introduced, sewers should follow immediately, in most kinds of soil: cesspools should not be used, unless with extraordinary precautions. But with a few hundred feet square of lawn, the irrigation system by agricultural drain-pipes is to be recommended, whereby the filth is at once taken up by the roots of grass. In all cases, of course, with or without cesspools, there should be thorough ventilation of the system of house-drainage, with disconnection from the main outlet drain by means of either a ventilating-pipe or rain-water spout between the sewer-trap and the house, and whose open-

[1] A strong cask, or elongated tub, was constructed, open at one end, and largest at the open end, hooped with iron, and hung upon iron pivots, which were placed so near the centre of gravity of the cask that it could easily be capsized by a push from the hand. The cask was hung over an opening in the floor of the privy, boxed around, and with a movable cover. Into it were thrown the contents of all slop-pails, bed-pans, and close-stools; and immediately after, a sufficient quantity of dry earth or coal-ashes was thrown in to absorb the whole. The earth was obtained from a bin, built upon the outside of the privy, so as to be filled from a cart outside, and with an opening at the level of the floor inside, from which the earth could be taken with a light shovel and thrown into the cask close by. The quantity of earth required to absorb a pailful of urine was found to be surprisingly small; and the disinfection was so complete that no odor whatever could be detected, except occasionally in the hottest days of summer, when, unless care were taken to dust the earth thoroughly over the sides of the cask, they would give off a faint ammoniacal odor. This was easily prevented by care; and the additional precaution was taken, in midsummer, of also throwing in disinfectants. To fill the cask, required from two to four weeks, according to the number of patients. When full, it was easily capsized into a brick vault below, which also received the excrement and earth from the earth-closet. It was found that the contents of this vault never gave off a particle of odor; but, as a safeguard, a pipe was carried from it to the kitchen chimney for ventilation. Whenever the vault became full, its perfectly cleanly contents were removed, and used as a fertilizer. The swinging cask would be a valuable addition to any dwelling-house or institution similarly situated, and could very easily be applied. If necessary, its form could be simplified, and the cost thus reduced.

[2] See pages 11 and 20.

ings at the top should be only at points remote from windows and chimney-tops.

On the whole, a thoroughly satisfactory arrangement of this kind, if properly looked after, is in many respects to be preferred to connecting with public sewers.

VIII. While the water-carriage system is the least offensive to a refined people, the least costly in the end if on a large scale, and, when well managed, the least objectionable from a sanitary point of view, it should be remembered: (1) that in the case of town and cities of moderate size its introduction involves the outlay of a large capital; (2) that the connections between houses and sewers can be made free from danger-bringing elements only with great care, and that usually from a want of such care they are often productive of a certain amount of harm, — a danger often very great, especially to children and delicate persons, since the possibility of the continuous ill effect on the system of a slight poison is not often recognized, and as few people can be induced to believe that any thing is a poison from which they cannot see immediate and striking ill results; (3) that the outlets of sewers, except near large bodies of water, generally involve a great deal of difficulty, and often of serious nuisance, from the fact that there is at present no really satisfactory way of disposing of the sewage, while a properly-arranged system of frequent dry removal is not attended with especial danger to health, and may at any time be changed for better methods without involving any great pecuniary loss.

When sewers are built, or sewerage systems adopted, the work should be planned and carried out only by the best available talent: for badly-constructed sewers are in many respects worse than none; and their proper arrangement and maintenance involve an amount of knowledge, skill, and experience, which are found only among men of unusual ability, who have had special opportunities for preparing themselves for their work.

Whichever of the three great disinfectants and destroyers of filth is used, — namely, *a sufficient quantity* of earth, water, or air and sunlight, — the essential process is the same: the effete matters are converted by oxidation and by chemical combination into products that are finally both harmless and

inoffensive. In all three the oxygen is the most important agent, and burning, or oxidation, is the essential process. The most offensive gases, however, to a certain extent when in the earth, and to a less degree in the water, are absorbed mechanically; in the earth, too, the foul-smelling sulphuretted hydrogen unites with the iron found in most soils, forming an inert and inoffensive compound. But in all three, unless the amount of filth is proportionately very small, there are certain gases escaping, and what are called emanations, — possibly, too, disease "germs," — often so minute or diluted as not to be appreciable to our senses. It is the part of prudence, therefore, to have any and all of these processes reasonably remote from dwellings, and within certain limits to destroy all filth by oxidation, sewage-irrigation, &c., with as little delay as may be necessary.

Cottage-Hospitals.

By Dr. J. F. A. Adams, of Pittsfield, Medical Correspondent of the Board.

It is hoped, that, to persons desiring to establish cottage-hospitals elsewhere, Dr. Adams's history and description of the excellent institution at Pittsfield may prove of service, both as a model, and as suggestive of their own peculiar needs; but the special wants of each locality must be such that no one plan would suit all towns, without modifications as to details. Such institutions are needed in many towns of this Commonwealth. The Board urgently recommend to those towns and cities which are not already provided with some means of filling so important a want, that they follow so good an example.

Dangers from Color-Blindness.

By Dr. B. Joy Jeffries, Surgeon to the Massachusetts Eye and Ear Infirmary.

In testing 611 instructors and students of different departments of Harvard University and the Institute of Technology, Dr. Jeffries has detected thirty color-blind, being very nearly one in twenty, — not a large ratio for the whole community. He has also shown the importance which this subject has assumed with reference to the protection of life on railway-trains and steamboats, and the attention which is directed to it in Europe, where, in one country alone

(Sweden), by the simple efforts of one scientific man, all the railroad-employés of the country were in a few months tested, and laws to govern the future were made and enforced.

We cannot do better than quote, with our unqualified approval, the writer's conclusions and recommendations, as follows: —

Certainly one in *fifty*, much more probably one in *twenty*, of the community, is color-blind in greater or less degree.

Of this defect they may even themselves be wholly unconscious.

This color-blindness may practically be regarded as *red-green* blindness or *blue-yellow* blindness. Total color-blindness also exists.

This defect is congenital. It exists in varying degrees. It is largely hereditary. It may also be temporarily or permanently caused by disease or injury.

It is incurable when congenital. Exercising the eyes with colors, and the ears with their names, helps the color-blind to supplement their eyes, but does not change or increase their color-perception.

Experiment and experience show that we are *forced* to use *red* and *green* marine lights, to designate a vessel's direction of motion and movements, and at least *red* lights on railways to designate danger.

Form instead of color cannot be used for these purposes.

There are many peculiar conditions under which railroad-employés and mariners perform their duty, which render colored signals, and especially colored lights, difficult to be correctly seen.

These signals can never be correctly seen by the color-blind.

There is, therefore, great danger from color-blindness.

Railway and marine accidents have occurred from it.

There is no protection but the elimination from the personnel of railways and vessels, of all persons whose position requires perfect color-perception, and who fail to possess it. This can now be readily and speedily done.

Therefore through a law of the Legislature, orders from State railroad commissioners, or by the rules and regulations of the railroad corporations themselves, each and every em-

ployé should be carefully tested for color-blindness, by an expert competent to detect it. All deficient should be removed from their posts of danger. Every person offering himself as an employé should be tested for color-blindness, and refused if he has it. Every employé who has had any severe illness, or who has been injured, should be tested again for color-blindness before he is allowed to resume his duties.

The same examination should be carried out amongst pilots and masters of steamers and sailing-vessels. These latter should also be especially instructed how to detect color-blindness among the personnel of their commands.

The Filtration of Potable Water.

By W. Ripley Nichols, Professor of General Chemistry in the Massachusetts Institute of Technology.

Few subjects are pressing upon authorities of towns and upon individuals at the present time with greater force than the proper supply of suitable water for domestic purposes. Its influence upon the public health has, for a long time, been recognized. For all that, there are so many difficulties in the way of satisfactorily meeting in a practical way all the problems connected with this important subject, that much disease is doubtless each year to be fairly attributed to the use of impure water. The writer of the paper presented in this report has been for several years engaged in the study of water-supplies, in co-operation with the State Board of Health. The matter has been treated in a thorough way, which cannot fail to be useful to all localities where the question comes up. The Board hope, therefore, that it will receive careful consideration from those who are called upon to decide upon the various plans submitted to them for supplying potable water to the various communities in our State.

Sanitation of Public Schools in Massachusetts.

By D. F. Lincoln, M.D., Secretary of the Health Department of the American Social Science Association.

This paper is founded upon the results of an inquiry into the site, construction, sewerage, drainage, and ventilation of schoolhouses in our State, and deals also with the question of the transmission of contagious diseases. Replies to the circular of the Board, representing almost all of the public

schools in Boston, and nearly forty thousand pupils in other parts of the State, indicate such a want of attention to the plainest sanitary laws, that even in our largest cities we find serious offence existing, and in some cases probable injury to health.

Our correspondents report, for instance, in a number of cases, such facts as the following : —

"The privies are near to the building, and of the *worst possible* construction, and in the worst possible condition. No kind of regard has been paid to cleanliness or decency in any of them."

Privies "not properly emptied and disinfected. *Decidedly* offensive odors." [This statement of the master is emphasized by the medical reporter, who says that the air of the second-story rooms is contaminated by the privies; "a state of things infernal in its origin and its character."]

"There are four open privies, two in the upper story, and two in the lower, poorly ventilated and not connected with a sewer. They are situated just in the rear of the schoolrooms, and open from them; are not in any way properly cleansed, and reek with foul odors, which penetrate the schoolrooms when the doors are opened. They open directly from the recitation-rooms."

It is plain that there is needed such an office in our State as the medical inspector of schools of Italy, France, Germany, Holland, and Belgium. In the rural districts greater skill, more independence, and a larger experience would be got by having one inspector serve over a district comprising several towns. The conclusions and recommendations of the writer, which we also advise, are as follows : —

Rules for Preventing the Spread of Contagion in Schools.

I. Vaccination, — a certificate to be required of every child entering the public schools, as is the law now in Massachusetts.

II. Physicians to be required, under penalties, to report to local boards of health all cases of dangerous infectious diseases observed by them, the board to inform principals of schools.

III. The existence of any case of such diseases in a house, to exclude the inmates from attendance at schools, for a suffi-

cient length of time; the propriety of re-admission being certified to by a competent physician.

IV. Disinfection[1] of premises and clothing, by the board of health, in every house where the above diseases have prevailed.

V. Medical authority to be designated, for the purpose of advising teachers and pupils, and pointing out to the school committee matters in regard to which their authority might be used to improve the sanitary condition of schools.

Scarlet-Fever.

By A. H. Johnson, M.D., Medical Correspondent of the Board in Salem.

We commend to the Legislature, to health authorities, and to all individuals, a careful consideration of the important subject so fully discussed in this paper. A mass of information has been collected and arranged by the writer in a manner to be of the greatest use to local boards of health and to school committees. A preventable disease which destroys 23,829 lives in Massachusetts alone in twenty years, should be met with such vigorous measures as seem to have succeeded so well in Boston by the action of the Board of Health and the School Committee of that city. The apathy of our authorities in the matter, however, renders it often impossible to use to advantage the information which we already possess. Doubtless the dilatory action, or the refusal to act, of the city and town officers who ordinarily serve as boards of health, has often allowed scarlet-fever to become much more general than it could have been with proper regulations; and many lives have been uselessly sacrificed in that way. The experience of new countries like Australia and New Zealand, where scarlet-fever has only lately been introduced through the agency of their civilizing friends, shows clearly that such contagious diseases are not a necessary part of modern civilization, provided means be taken to isolate each case of the disease, and to use disinfection thoroughly enough to destroy the contagium. For this latter purpose, nothing is known which is certain to be efficient in all cases, except heat, sufficient and prolonged, although there are other means which are undoubtedly useful within certain

[1] As to disinfection, the reader is referred to the account of the methods now most approved, contained in the present Report, in a paper on Scarlet-Fever.

limits. The whole paper should be carefully weighed; and we hope that it will be the means of awakening our communities to a more active sense of their responsibility for so large a measure of mortality among those who are too young, in the vast majority of cases, to legislate in a manner to protect themselves.

The Sanitary Condition of Cambridge.

By Edward R. Cogswell, M.D., Medical Correspondent of the Board in Cambridge.

This paper, the second in a series on the sanitary condition of our cities, presents in a clear light the urgent need of better attention to the laws of health governing communities. Thus far the jealousy of the rights of the individual has allowed one person, in too many instances, to injure his neighbor's health. The principles of sanitation as affecting large masses have been especially neglected in the matter of using undrained lands for building-lots in Cambridge; the sewerage and water-supply of the city, too, are in a far from satisfactory condition. It is to be hoped that the newly appointed Board of Health will be able to remedy many of the evils existing in Cambridge, as pointed out by the writer of the paper on that city's sanitary state. The question is one in which all classes are interested, inasmuch as the pestilence which is fostered and which gathers strength in the worst localities may reach with greater virulence those living under better circumstances, and perhaps more sensitive to any morbific poison.

Health of Towns.

This department of the inquiries of the Board becomes more extended each year; and it is their desire to very much further increase their knowledge of the individual wants of the various localities, so as to be able to advise more fully, from time to time, with regard to the best courses to pursue in order to meet the varying circumstances conspiring to lower the health and vigor, or to increase the mortality, of the community. The recent votes of the cities with regard to establishing boards of health must convince any one that far too little interest is taken, in a matter of so vital importance, by the people of the State.

Hydrophobia.

In accordance with Chapter 167, Section 4, of the Acts of the Legislature of 1877 here quoted, the following statement was issued by the Board, April 27, 1877: —

"Every license issued to the owner of any dog in this Commonwealth shall have printed on the same a description of the symptoms of the disease in animals known as hydrophobia; said description to be supplied on application by the Secretary of the Board of Health."

The animals known to be *primarily* affected with hydrophobia are chiefly dogs; although cases have occurred in other allied species of carnivorous animals (wolf, fox, hyena, raccoon, badger, cat, skunk, &c.). The disease may be communicated, by *inoculation*, to probably all warm-blooded animals. It prevails most in temperate climates, and pretty uniformly at different seasons. (In the United States, of 2,407 cases, 671 occurred in spring, 583 in autumn, 580 in summer, 573 in winter.) It is thought by the best authorities to affect both sexes in dogs about alike, although there are more cases occurring of male dogs, as there are more male dogs in existence.

There is no evidence that men can have hydrophobia, except by direct inoculation from an infected animal; and all men bitten by mad dogs do not necessarily have the disease, even when no treatment is adopted.

No kinds of dogs, so far as is known, are specially liable to hydrophobia, except in a general way those which live under unnatural conditions of climate, food, &c. Poodle-dogs, pet dogs, and those living in heated houses, with little exercise, and fed with unsuitable food, &c., half-starved, stray dogs, and unacclimated dogs, are more likely to have hydrophobia than others. All mad dogs do not necessarily bite other animals, if not interfered with; but it is evident, that the more ferocious the nature of the dog, either originally or by education, the greater are the chances of his biting people, and thereby communicating the disease.

The symptoms in dogs are referable to three stages, *in no one of which* is there any dread of water (which is a symptom of the disease in man alone, and not always in him); indeed, a mad dog is usually more than commonly thirsty.

In the *first stage*, there is a change in the habits of the dog: he becomes dull, gloomy, and silent, seeks to isolate himself in out-of-the-way places, is very restless, lying down and getting up frequently, constantly changing his position, and being in a continual state of agitation. The appetite is capricious, and only delicacies are eaten at first, while a little later all manner of

strange material, sticks, stones, straw, dung, &c., are greedily taken. The animal appears sullen, and obeys his master's voice less readily than usual, although for a few moments he may seem more lively than is common. Sexual excitement is generally an early symptom. There is seldom an increased disposition to bite in this stage, and there is no frothing at the mouth; but the saliva is capable of communicating the disease. Petted dogs are especially dangerous in this condition, because their bite, if trivial, is liable to be overlooked and not treated, and because they are allowed to lick the face and hands of their owners, and may inoculate any small spot where the skin is broken.

From twelve hours to two or three days later, in the *second stage*, the restlessness becomes more marked; the dog throws about the straw in his kennel, scratches and tumbles cushions, rugs, &c., is constantly in motion, and acts as if impelled by some fancies or hallucinations of sight and hearing. He starts as if attacking some object, darts forward, snaps at imaginary objects, and then is quiet for a moment; the saliva now becoming free and virulent, he froths at the mouth; his eyes are red and fierce-looking, the pupils dilated. He soon escapes all control, and wanders ferociously about, as if impelled by some irresistible force, and attacking, without snarling or barking, any living thing, especially dogs, while there are occasional paroxysms of fury or muscular spasms in which there is great evident suffering, succeeded by lassitude and momentary insensibility. In these spasms[1] the muscles of the throat are more or less affected, and the voice of the animal becomes dry and husky, somewhat resembling that of a child in croup, while the thirst is inordinate. If kept in a dark, quiet place, these spasms usually do not appear.

In the *third stage*, of paralysis, especially of the mouth and jaw, there is inability to bite; and the great majority of dogs who live so long die of exhaustion, with blindness, inability to swallow, emaciation, &c. The voice is nearly or quite absent throughout this stage.

There is also a form of hydrophobia called "dumb madness," in which the violent or second stage is aborted; the early paralysis of the muscles of the throat and vicinity causes the lower jaw to drop, and the mouth to remain open, with inability to make a loud noise. Less than ordinary sensibility to pain, a disposition to attack other dogs, and an unusual courage, are present in this, as in the other, form of the disease.

[1] It should be said that convulsions or fits are not uncommon in dogs, and that they do not necessarily indicate any serious disease; they are not distinctive of hydrophobia.

A few dogs recover without having done any harm ; but the safest way is to kill them at once, as soon as the disease is made certain.

Hydrophobia may be communicated to men by the saliva of dogs which have been for some hours dead.

Of course all the symptoms above detailed may not appear in any one individual dog, for no two cases will be strictly and exactly alike ; but it is believed that the detection of hydrophobia may be generally made easy by careful observation and attention to these points. In general, it may be said that a sick dog, especially if sullen, with a capricious appetite, and unusually inclined to attack other dogs, should be kept under close surveillance, and at once killed if unequivocal signs of hydrophobia appear.

If wounds from rabid animals are thoroughly washed and cauterized *at once* with a white-hot iron, or with nitrate of silver, it is shown by statistics, that an attack of the disease may be avoided in the vast majority of cases. Internal medicines are of no consequence as preventives.

Diphtheria.

The wide and fatal prevalence of diphtheria in many parts of Europe and America, from St. Petersburg to San Francisco, and especially in our own State, has led the Board to distribute the following circular, somewhat widely, through their medical correspondents and the local boards of health.

State Board of Health, Boston, Oct. 1, 1877.

Dear Sir, — In view of the fact that diphtheria, although now less prevalent than in the colder months, may be expected to visit a portion of our State during the autumn and winter, it seems important that more thorough attempts to control the disease should be made by the local authorities.

In the first place, as diphtheria is a contagious disease, and, under certain circumstances not entirely known, very highly so, it is important that all practical means should be taken to separate the sick from the well. As it is also infectious, woollen clothes, carpets, curtains, hangings, &c., should be avoided in the sick-room, and only such materials used as can be readily washed.

All clothes, when removed from the patient, should be at once placed in hot water. Pocket-handkerchiefs should be laid aside, and in their stead soft pieces of linen or cotton cloth should be used, and at once burned.

Disinfectants should always be placed in the vessel containing the expectoration, and may be used somewhat freely in the sick room ; those being especially useful which destroy bad odors with out causing others (nitrate of lead, chloride of zinc, &c.).

In schools, there should be especial supervision, as the disease is often so mild in its early stages as not to attract common attention; and no child should be allowed to attend school from an infected house, until allowed to do so by a competent physician.

In the case of young children, all reasonable care should be taken to prevent undue exposure to the cold.

Pure water for drinking should be used, avoiding contaminated sources of supply; ventilation should be insisted on, and local drainage must be carefully attended to. In country towns, privies and cesspools should be frequently emptied and disinfected; slop-water should not be allowed to soak into the surface of the ground near dwelling-houses, and the cellars should be kept dry and sweet.

In cities, especially in tidal districts, basins, baths, etc., as now connected with drains, should never communicate directly with sleeping-rooms. In view of the fact that the majority of our houses are improperly supplied with local drainage, and that this is probably at least as great a source of disease as bad sewers; in view of the fact, too, that many cities are likely to appoint boards of health by virtue of the authority conveyed upon them by Chapter 133 of the Acts of the General Court of 1877, — the Board desire to call attention to the following important section of that Act: —

"SECTION 5. *Said boards of health, and the Board of Health of the city of Boston, in addition to the powers conferred upon them by existing statutes, are hereby authorized to prepare and enforce, in their respective cities, such regulations as they may deem necessary for the safety and health of the people, with reference to house-drainage, and its connection with public sewers, where such connection is made.*"

In all cases of diphtheria, fully as great care should be taken in disinfecting the sick-room, after use, as in scarlet-fever.

After a death from diphtheria, the clothing disused should be burned or exposed to nearly or quite a heat of boiling water: the body should be placed as early as practicable in the coffin with disinfectants, and the coffin should be tightly closed.

Children at least, and better adults also in most cases, should not attend a funeral from a house in which a death from diphtheria has occurred. But, with suitable precautions, it is not necessary that the funeral should be private, provided the corpse be not in any way exposed.

Although it is not at present possible to remove at once all sources of epidemic disease, yet the frequent visitation of such disease, and especially its continued prevalence, may be taken as

sufficient evidence of insanitary surroundings, and of sources of sickness to a certain extent preventable.

It should be distinctly understood that no amount of artificial "disinfection" can ever take the place of pure air, good water, and proper drainage, which cannot be gained without prompt and efficient *removal of all filth*, whether from slaughter-houses, etc., public buildings, crowded tenements, or private residences. In the opinion of the Board, this is likely to be done properly only through independent local boards of health, the appointment of which in all cases we most respectfully, but earnestly, urge upon the citizens of the State.

We have the honor to be,

Very respectfully yours,

HENRY I. BOWDITCH,
ROBERT T. DAVIS,
RICHARD FROTHINGHAM,
DAVID L. WEBSTER,
JOHN C. HOADLEY,
THOMAS B. NEWHALL,
CHARLES F. FOLSOM,

Members of the State Board of Health.

Scarlet-Fever.

Although scarlet-fever is not now especially prevalent, and the year has been more than commonly free from its ravages, the attention that will naturally be drawn to the subject by the carefully-prepared paper in the present report furnishes an occasion for the issue of a circular on the subject, which the Board had intended to send to their correspondents, and to local boards of health, at the approach of the next epidemic.

SUGGESTIONS FOR PREVENTING THE SPREAD OF SCARLET-FEVER.

A Circular from the State Board of Health of Massachusetts.

Scarlet-fever, scarlatina, scarlet-rash, canker-rash, and rash-fever are names of a contagious and infectious disease of varying degrees of severity; but in which all the forms are capable of conveying the most severe type. A person may become ill with fatal scarlet-fever from association with another who had so mild an attack of the disease as not to keep him in the house, much less in bed.

The hypothesis of a "germ" in scarlet-fever, analogous to the spores of minute vegetable growths, which is of organic nature and capable of indefinite multiplication outside of the body, is

maintained by some scientific observers, but is held by other authorities to be at variance with many observed facts.

It is generally agreed among sanitarians, that scarlet-fever is conveyed from one person to another by means of the epithelium or thin superficial covering which extends over the whole body, under the name of epidermis, cuticle, or scarf-skin, and which also lines the inner passages of the body. The exhalations from the outer and inner surfaces of the various parts of the body, and from the excretions also, are capable of transmitting the disease. Upon whatever the contagious matter depends for its dangerous character, it is capable of retaining its power to carry the disease for a long time — certainly many months, and possibly for a year or more — unless destroyed.

The means of transporting the contagium of scarlet-fever may be furnished by any thing that has come in contact with an infected person or object, — air, food, clothing, sheets, blankets, whiskers, hair, furniture, toys, library-books, wall-paper, curtains, cats, dogs, &c. Funerals have occasionally spread the disease, the exhalations from the dead body being also dangerous.

The period from exposure which results in scarlet-fever, to the time when the symptoms manifest themselves, varies from several hours to three, and possibly four, weeks. The average time is variously given from six to eight or ten days.

The time at which one who has been ill with scarlet-fever may safely mingle with other people is not always easy to determine; but it is, for convenience, usually placed by sanitarians at four weeks from the commencement of the illness, as that covers the vast majority of cases, and it is best to have some arbitrary rule. A physician's certificate, however, should be always required.

It would be well to designate every house where scarlet-fever exists, by some mark not too conspicuous, and yet sufficient to give the proper information.

The first principle of treatment is in isolation, which can be nowhere so well observed as in a hospital, provided the patient is old enough to go there. Otherwise he should be placed in a room as much separated from the rest of the house as possible, and communicate with no more members of the household than is absolutely necessary. If an outward draught of air from the sick-room to the entry occurs, a curtain may be formed by a sheet which is soaked in some disinfectant; those which have not a disagreeable odor, and do not stain clothing, being preferred.

The sick-room should be well warmed and ventilated (by an open fireplace with a fire or a lamp in it, if possible). It should be open to the sun, as free as possible from noise, dust, &c., and no

" aired " by cold draughts, which are often more dangerous than a foul atmosphere.

All carpets, upholstered furniture, window-hangings, and, indeed, unnecessary objects of every kind, especially woollen, should be removed from the room. Bits of carpet may be used, and burned after the need for them has passed.

The discharges from the throat, nose, and mouth of the patient may be put in a vessel containing a strong solution of some " disinfectant," which shall be frequently washed with hot water: they should not be received upon any thing which is to be kept. Pieces of soft cloth, which should be at once burned, may be used in place of pocket-handkerchiefs. The breath should be kept as pure as may be, by cleansing gargles and washes for the mouth (chlorinated soda, permanganate of potash, &c.). The discharges from the kidneys and bowels should be disinfected with boiling water, to which some deodorizer (nitrate of lead, chloride of zinc, sulphate of iron, carbolic acid, chloride of lime, &c.) may be added. Carbolic acid may be added as a " disinfectant " to the slops, and to the water in which the patient has washed, before throwing it out. The skin is usually more comfortable in feeling if cosmoline, &c., or sweet-oil, with a couple of grains of camphor to the ounce, is used for anointing it; the scales of the epidermis are also thereby prevented, to a considerable degree, from escaping freely into the air. The bed-clothes, towels, &c., when disused, should be removed with proper care, and be boiled for a couple of hours. The food left uneaten should never be carried where it may infect other persons.

While the sick-room is occupied, it is doubtful whether any *disinfectant* can be used of sufficient strength to destroy the contagium. Many substances, however, do destroy organic matter by oxidation, and in that way at least contribute to cleanliness if nothing more. For that purpose it is desirable to use nitrate of lead, chlorinated soda, chloride of zinc, permanganate of potash, &c., because they do not stink of themselves. It has been thought that the ancient custom of burning aromatic balsams, &c., contributed powerfully to disinfection.

Attendants on the sick should be as few as possible, and should not communicate with other persons any more than can be helped. They should wear only such clothing as may be readily washed. Clothes used in the sick-room should be boiled before being worn elsewhere. Gargling or washing the mouth occasionally with a cleansing fluid is a useful measure for those who must be exposed to contagion; and in washing the hands, a little Condy's fluid (permanganate of potash) may be placed in the basin.

After recovery, the patient should not mingle with other per-

sons, use lounges, carriages, public rooms, &c., liable to be used by others, until all roughness of the skin has disappeared, and until he has taken warm baths for several days.

After the sick-room is no longer needed as such, all the clothing and other matters used in it, that can be washed, should be soaked in boiling water; others should be placed in a hot-air chamber, and kept at a temperature of 212° F. for several hours. Any articles of trifling value may be destroyed by fire. The wall-paper should be soaked with carbolic acid, removed and burned. The ceiling should be washed with soap and hot water, or scraped. The room should then be closed as tight as possible, and as much sulphur burned in it as the air will allow (a pound is an abundant amount for an ordinary room); it should be kept closed from six to eight hours, and then opened for several days to the air and sunshine. The floor and wood-work should then be thoroughly washed with soap and hot water. Scraping and repainting would not be considered an excess of caution in time of epidemics.

Should the sick person die, the body ought not to be removed from the sick-room until it has been sealed in the coffin, with carbolate of iron, carbolized earth, or some similar agent. It is advisable that the funeral should be as private as possible, and not attended by children.

Any thing which deteriorates health tends to render the system liable to any disease; and in that sense filth may be considered to promote scarlet-fever, or to increase its mortality. Perfect cleanliness should therefore be enjoined. Sewer-gas, of course, is a kind of filth which may bring to one person's chamber, if it has access thereto, the contagium brought from another chamber and not disinfected. Overcrowding is one of the most active ways of propagating contagious disease. Finally, fresh air is one of the best disinfectants.

In our State, there is a local board of health in every town, although in too many cases consisting of a body of men who are sufficiently occupied with other duties, and who in their character of selectmen act *ex officio* as guardians of health. To each one of these boards the law gives full authority to take every step that is needed in the preventive measures to be adopted in case of scarlet-fever. The sections with regard to isolation are from Chapter 26 of the General Statutes, and as follows: —

Section 47. When a householder knows that a person within his family is taken sick of . . . any . . . disease dangerous to the public health, he shall immediately give notice thereof to the . . . board of health of the town in which he dwells. If he refuses or neglects to give such notice, he shall forfeit a sum not exceeding one hundred dollars.

SECTION 38. When a physician knows that any person whom he is called to visit is infected with . . . any disease dangerous to the public health, he shall immediately give notice thereof to the . . . board of health of the town; and if he refuses or neglects to give such notice he shall forfeit for each offence a sum not less than fifty nor more than one hundred dollars.

The Board of Health of Boston at present require small-pox, scarlet-fever, diphtheria, and typhus-fever to be reported to them. Sufficient power is given to school committees also, to restrict the attendance at school of children from infected houses.

These rules for the prevention of scarlet-fever should be carried out *only* under the direction of physicians or boards of health.

We are fully aware that many individual cases of scarlet-fever occur without any spread of the disease; but the rule is to the contrary, and we have no means of knowing that we are safe, without taking precautions which a different course might occasionally have proved to be unnecessary.

Prevalent Diseases, etc.

The investigations with regard to diphtheria in Taunton and Gloucester, and typhoid-fever in Raynham, Saugus, and Taunton, with the mass of information furnished by our correspondents in their replies to our annual circulars, furnish a large amount of material to show the need of efficient sanitary work in our towns and cities throughout the State.

Taunton furnishes an example of the evils of introducing public water-supplies without sewers, in a place already needing drainage to remove the surplus water in the soil. Dr. Deane, city physician, and one of the medical correspondents of the Board, shows so clearly the necessity of more efficient sanitary work in that city, that it is to be hoped there will be no further delay in carrying it out.

Gloucester has a polluted soil and a contaminated well-system, so that it is doubtful whether pure drinking-water exists in many of the wells. Their cisterns, too, are not in all cases provided with sufficient guards to keep the water free from impurity. In that city, the thin soil overlying rock renders general contamination inevitable, where filth is allowed to soak into it without limit. The introduction of a water-supply and sewerage through the rocky ledges would be enormously expensive: so that there seems nothing left but some properly-arranged system of dry-removal, to keep the

filth out of the soil, together with the introduction of cisterns with suitable filtering arrangement for supplies of drinking-water. Where water-closets are introduced, irrigation of some sort, either under the soil or above it, may be found useful. In course of time, it is possible that the soil might become pure enough to resume the use of carefully-guarded wells.

With the exception of the local prevalence of diphtheria in many places, the health of the State is thought by our correspondents generally to have been exceptionally good during the past year. Some of them attribute that fact partly to the depression in business, the necessity of frugality, and the avoidance of excesses.

We desire to thank our medical correspondents, in our own behalf and in that of the community, for the valuable information which their kind and hearty co-operation in our work has allowed us to lay before the public.

We thank the registrars of the more populous places in the State for their courtesy in furnishing us each week the statistics from which the mortality-reports are prepared and published in the "Boston Daily Journal" of each Thursday.

As the metric system is likely to come into general use in the near future, and as measurements are given in accordance with it in various parts of the Report, a table of equivalent values is given, as has been done for the past two years.

All of which is very respectfully submitted.

HENRY I. BOWDITCH,
ROBERT T. DAVIS,
RICHARD FROTHINGHAM,
DAVID L. WEBSTER,
JOHN C. HOADLEY,
THOMAS B. NEWHALL,
CHARLES F. FOLSOM,
Members of the State Board of Health.

The Metric System.

Length.

1 Myriameter, .	. Mm.	(10,000 m.)	= 6.2137 miles.
1 Kilometer, .	. Km.	(1,000 m.)	= 0.62137 mile.
1 Hectometer, .	. Hm.	(100 m.)	= 328.0833 feet.
1 Decameter, .	. Dm.	(10 m.)	= 393.7 inches.
1 Meter, . .	. m.	(1 m.)	= 39.37 inches.
1 Decimeter, .	. dm.	(0.1 m.)	= 3.937 inches.
1 Centimeter, .	. cm.	(0.01 m.)	= 0.3937 inch.
1 Millimeter, .	. mm.	(0.001 m.)	= 0.03937 inch.

Surface.

1 Hectare, . .	. Ha.	(10,000 sq. m.)	= 2.471 acres.
1 Are, . .	. a.	(100 sq. m.)	= 119.6 square yards.
1 Centare, . .	. ca.	(1 sq. m.)	= 1.550 square inches.

Capacity.

1 Kiloliter or Stère, .	Kl. or st.	(1,000 l.)	= 1.308 cubic yards	= 264.17 gallons.
1 Hectoliter, .	. Hl.	(100 l.)	= 2 bushs. and 3.35 pecks	= 26.417 "
1 Decaliter, .	. Dl.	(10 l.)	= 9.08 quarts	= 2.6417 "
1 Liter, . .	. l.	(1 l.)	= 0.908 quart	= 1.0567 qts. (1.761 imperial pints.)
1 Deciliter, .	. dl.	(0.1 l.)	= 6.1022 cubic inches	= 0.845 gill.
1 Centiliter, .	. cl.	(0.01 l.)	= 0.61022 cubic inch	= 0.338 fluid ounce.
1 Milliliter, .	. ml.	(0.001 l.)	= 0.061 cubic inch	= 0.27 fluid drachm.

Weight.

1 Millier or Tonneau,	M. or T.	(1,000 Kg.)	= 1 Kl. or 1 Cu. m.	= 2204.6 lbs. (avoirdupois.)
1 Quintal, . .	. Q.	(100 Kg.)	= 1 Hl. or 0.1 Cu. m.	= 220.46 pounds.
1 Myriagram, .	. Mg.	(10 Kg.)	= 1 Dl. or 10 Cu. dm.	= 22.046 "
1 Kilogram, .	. Kg.	(11,000 g.)	= 1 l. or 1 Cu. dm.	= 2.2046 "
1 Hectogram, .	. Hg.	(100 g.)	= 1 dl. or 0.1 Cu. dm.	= 3.5274 ounces.
1 Decagram, .	. Dg.	(10 g.)	= 1 cl. or 10 Cu. cm.	= 0.3527 ounce.
1 Gram, . .	. g.	(1 g.)	= 1 ml. or 1 Cu. cm.	= 15.432 grains.
1 Decigram, .	. dg.	(0.1 g.)	= 0.1 ml. or 0.1 Cu. cm.	= 1.5432 "
1 Centigram, .	. cg.	(0.01 g.)	= 0.01 ml. or 10 Cu. mm.	= 0.1543 grain.
1 Milligram, .	. mg.	(0.001 g.)	= 0.001 ml. or 1 Cu. m.	= 0.0154 "

One kilogram is equal to a weight represented by one liter of distilled water at 4° C. In the centigrade scale 0 (32° + F.) is the freezing point; 100° + (212° + F.) is the boiling point. Five degrees C. corresponds to nine degrees F.

All measures in the metric system are derived from the meter, and their names express their values. Some of the names in the French system (like our " dime ") are not in practical use; e.g., hectometer, decagram, etc.

One inch = 2.5 centimeters nearly; one quart (wine measure) = 0.946 liter; one pound troy = 0.373 kilogram; one acre = 0.4046 hectare.

EXPENSES OF THE BOARD.

Mounting Maps,	$4 75
Drawings for Maps, &c.,	127 50
Preparation of Plans of the Brighton Abattoir,	16 35
A. J. Wright, State Printer,	140 27
Rand, Avery, & Co., State Printers,	158 15
Surveys of Housatonic and Hoosac Basins,	463 38
Expenses in Housatonic and Hoosac Basins,	63 90
Surveys of Gloucester and Expenses,	194 35
Books, Reports, &c., and Binding,	472 69
Postage-Stamps and Stationery,	515 42
Travelling Expenses,	201 58
Carriage and Horse Hire,	37 00
Express and Freight,	45 73
Telegrams,	60
Messenger,	67 00
Clerical Services, T. H. Hay,	177 75
" " (Statistics of Insanity),	25 00
" " (Phthisis),	20 00
" " (Infant Mortality),	104 05
" " (Indexing Report),	38 45
" " (Copying Records),	3 00
Boston Journal,	35 88
Sheriffs' Serving Notices,	13 62
Translating for Paris Exposition,	24 00
Proof-Reading,	20 00
Chemical Examinations in Berkshire County,	202 00
" " in Cambridge,	109 00
" " in Gloucester,	180 00
" " in Saugus,	50 00
" " in various Towns,	101 40
Miscellaneous,	1 20
Special Reports and Investigations (Dr. J. F. A. Adams, E. R. Cogswell, A. S. Deane, C. N. Hulbert, B. Joy Jeffries, A. H. Johnson, D. F. Lincoln, W. Ripley Nichols, F. E. Oliver),	1,384 30
	$4,998 32

Erratum.

In the Eighth Report of the Board, page 123, the impurities of the water in Eagley Brook are given in results per 1,000,000, instead of in parts per 100,000, as stated in the text.

DRAINAGE AND HEALTH;

SEWERAGE;

AND

THE POLLUTION OF STREAMS;

INCLUDING A DRAFT OF A LAW.

A REPORT BY THE STATE BOARD OF HEALTH.

THE POLLUTION OF STREAMS.

In continuation of the investigations begun in 1875, the basins of the Hoosac and Housatonic rivers, comprising the greater part of Berkshire County, have been examined during the past year. The surveys have been made, as previously, by Mr. E. K. Clark, C.E., the various localities having been visited later by the Secretary of the Board; and the chemical examinations, as usual, have been made by Professor Wm. Ripley Nichols, at the laboratory of the Massachusetts Institute of Technology.

Circulars were also sent to the medical correspondents of the Board, and to the chairmen of the selectmen of the towns in the two basins, asking replies to the following questions: —

I. Is there any pollution of ponds or streams in your town, arising from —

(*a*) manufactories or mills;

(*b*) town sewage, &c.?

II. If so, what is —

(*a*) the character of the pollution (lime, dyestuffs, excrement, street-washings, &c.)?

(*b*) its extent (effect on color, smell, &c., of the stream, influence on fish, &c., whether offensive, unfit for cattle to drink, &c.)?

III. Does the offensive matter, if any, come from your own town, or from another?

IV. What is the source of your water-supply?

(*b*) Is it free from contamination?

V. Are there *any complaints* from manufacturers, or others, of the pollution of streams in your town?

VI. To what extent are you troubled by wet cellars?

VII. What is the character of the soil in your town, — light, heavy, dry, damp, or wet, &c.?

Replies from Towns.

A summary of these replies gives the following facts: —

Alford. — The Green River and a branch pass through this town. Each has a grist-mill and saw-mill standing thereon. No pollution of the water, except by sawdust.

Domestic water-supply from wells and springs.

No complaints of wet cellars; hardly any stagnant water to be found in the town.

Cheshire. — One tannery, one cotton factory, with its privies, and some pig-pens on the banks of the river, pollute the stream somewhat; but a greater nuisance is from unremoved filth.

Domestic water-supply is from pure mountain springs. The pollution of the stream has been complained of, but not of late.

In some localities, troubled a great deal with wet cellars.

Clarksburg. — [*No reply.*]

Dalton. — No serious pollution, and no complaints.

Domestic water-supply from wells and springs.

No wet cellars.

Egremont. — No pollution and no complaints.

Domestic water-supply from a mountain brook.

No serious trouble from wet cellars.

Great Barrington. — No serious pollution.

Domestic water-supply from a mountain stream. Soil dry, and very little trouble from wet cellars.

Hancock. — Some pollution, of no great extent, from lime and dyestuffs. The water-supply is from springs and wells.

There is very little trouble from wet cellars; and the soil is mostly gravelly.

Hinsdale. — Pollution chiefly from dyestuffs of four woollen mills, but no perceptible effect on the stream a few rods below its entrance; is not offensive or unfit for cattle to drink; has no influence on fish. No complaints.

Domestic water-supply from springs and wells.

Cellars generally dry; some wet in the spring.

Lanesborough. — No pollution.

Domestic water-supply from wells and springs.

Not wet cellars to a great extent.

Lee. — No serions pollution, and no complaints.

Domestic water-supply from wells and springs.

Not any trouble from wet cellars.

Lenox. — No pollution.

Domestic water-supply from a mountain spring.

Wet cellars have disappeared since introduction of sewerage. Soil dark clay, very dry, lime soil.

Monterey. — No pollution of streams; but local house drainage is not always of the best.

Domestic water-supply from wells.

Not much trouble from wet cellars.

Mount Washington. — No pollution.

Domestic water-supply from springs; a few wells.

No wet cellars. Soil generally dry, some damp, very little wet.

New Marlborough. — No pollution of streams, and no trouble from wet cellars.

New Ashford. — [*No reply.*]

North Adams. — The sources of pollution are dyestuffs, street washings, and human excrement, as many privies are located on the banks of the stream. There is very little sewerage in the town, and the discharge from that is into the river. The junction of the northerly and southerly branches of the Hoosac River is in this village; there are, one print-works, five cotton-mills, two woollen-mills, and three large shoe-factories, all of which pollute the stream more or less.

The domestic water-supply is from mountain streams.

There are complaints that our ice is gathered for the summer from a pond artificially made for that purpose, in the south branch, not one-quarter of a mile from the town: it is highly polluted with all sorts of contamination.[1]

Many of our cellars in the south part of the village are very wet. The low land is very wet and heavy; the hilly is for the most part dry and gravelly.

Pittsfield. — Some pollution, chiefly from lime, dyestuffs, excrement, street-washings, &c., rendering the color of the water darker; no smell; has driven most of the trout from the stream; not offensive; all kinds of stock drink the water freely. There are no complaints of it.

Domestic water-supply from Ashley Lake, 600 feet above the town, fed by springs, and free from contamination.

Very little trouble from wet cellars; soil principally dry and gravelly.

Richmond. — No pollution.

Only few wet cellars; soil, clay loam; considerable swamp.

Sheffield. — No pollution.

Domestic water-supply from springs and wells.

Not much trouble from wet cellars; soil, loam sand.

[1] This point will be again referred to at a later page.

South Adams. — [*No reply.*]

Stockbridge. — No pollution, unless the emptying into the Housatonic River of wastage from paper-mills (chiefly in South Lee) and one woollen-mill is called pollution, which I would hardly consider such, as the stream flows quite rapidly through the town. There is no appreciable effect on the color, &c., of the river here. The waste from paper-mills in South Lee passes into the Housatonic, and in former years, when mixed with the scrapings from two tanneries, produced a deposit in the still parts of the stream, causing its bed to be so offensive that gravel from it, when used in one instance for a yard-walk, had to be removed; this deposit, exposed to the air, was supposed to be productive of periodical typhoid fever. The tanneries were stopped, and water from mountain springs was introduced, since which time — say fifteen years — there has been no typhoid fever, except when traceable to local causes. There is no pollution from town sewage, as each family disposes of the sewage material. Covered cesspools for water-closets, having ventilating pipes reaching above the chimneys, and pipes also from the lids of the closets passing through and out of the chimneys, are thought to constitute the best plan; disposing of the kitchen waste in a distinct covered cesspool, with an open or temporarily covered spout emptying into a bucket, with a hopper to keep the bucket full and prevent all escape of gas, is, I think, the approved plan, though not generally adopted, except by a part of the village. Every farmer should have such a contrivance, and then periodically run the sewage, disinfected, upon the land.

Domestic water-supply from mountain springs, partly through galvanized iron pipes.

No wet cellars in the village; soil light, sandy, and gravelly in the village.

Tyringham. — No pollution.

Domestic water-supply from wells and springs.

Not much trouble from wet cellars; soil, sandy loam in the valley, and rocky upon the hills.

Washington. — No pollution.

Domestic water-supply from springs.

No wet cellars; soil, dry and sandy, but in parts heavy and wet.

West Stockbridge. — No pollution.

Domestic water-supply from springs and wells.

Very few wet cellars.

Williamstown. — Some pollution from dyestuffs and excrement. Where the raceway of the Blackinton mills enters the Hoosac

River, the water is dark but not particularly offensive — unfit for any thing to drink. There are no complaints that I have heard of.

Domestic water-supply from a mountain spring.

Cellars are mostly dry. The soil in the town is variable, — clay, sand, and gravel, — with humidity corresponding; in most of the village it is gravel, with clay subsoil.

From these several sources of information, chiefly, the following account has been prepared.

Area and Population.

Berkshire County has an area of 894.34 square miles, with a population of 68,265, by the census of 1875, or 76.33 inhabitants to the square mile. In the Hoosac basin, within the State, there were, by Mr. Clark's tables, 22,136 inhabitants in 1875, with an area of 228 square miles, or 97 persons to the square mile. The Housatonic basin has an area of 428 square miles, with a population of 37,203, or 87 inhabitants to each square mile.

Pittsfield, North Adams, South Adams, and Great Barrington are the only places with a population of over 4,000.

Eighteen of the 31 towns have now fewer inhabitants than in 1855, while the total increase for the county in that time has been 29.31 per cent. Most of the farming towns, especially those not lying near railroads, have decreased in numbers of inhabitants, while Adams is the only town that has doubled its population in the twenty years.

The following table shows the distribution and movement of the population in the last twenty years. The towns in italics are chiefly or wholly outside of the two drainage areas examined; those marked with an asterisk lie partly in the Hoosac and partly in the Housatonic basin. Where the increase is not over ten per cent the sign + is used; where there is an actual decrease the sign —. A reference to the maps on pages 26 and 50 will serve to mark the various places, by which it may also be seen that the towns engaged in manufacture are mainly those which have grown. A large part of the increase of Adams and Pittsfield is, of course, due to their being prominent railroad centres.

There are so few mill privileges unoccupied, that it is hardly reasonable to attribute any great prospective increase to further growth of manufacturing.

TABLE I. — *Area and Population of Towns in Berkshire County.*

	Whole Area of Towns in Sq. Miles.	Sq. Miles within Drainage Area.	Population in 1855.	Population in 1865.	Population in 1875.	Increase per cent 1855 to 1865.	Increase per cent 1865 to 1875.	Increase per cent 1855 to 1875.
Adams, . .	44.03	41.79	6,980	8,298	15,760	18.88	89.93	125.79
Alford, . .	9.41	9.41	526	461	389	—	—	—
Becket, . .	45.58	.58	1,472	1,393	1,329	—	—	—
Cheshire, . .	31.94	31.94	1,532	1,650	1,693	+	+	+
Clarksburg, .	13.03	13.03	426	530	670	25.00	26.42	58.02
Dalton,* . .	19.09	19.09	1,064	1,137	1,759	+	54.71	65.32
Egremont, . .	16.31	16.31	992	928	890	—	—	—
Florida, . .	24.97	.65	612	1,173	572	91.67	—	—
Gt. Barrington, .	39.52	39.52	3,449	3,920	4,385	13.66	11.86	27.14
Hancock,* . .	36.79	14.73	848	937	730	14.94	—	—
Hinsdale, . .	18.06	18.06	1,361	1,517	1,571	11.45	+	15.43
Lanesborough,*.	28.04	28.04	1,235	1,294	1,357	+	+	9.88
Lee, . . .	21.47	21.47	4,226	4,035	3,900	—	—	—
Lenox, . .	19.76	19.76	1,895	1,660	1,845	—	11.14	—
Monterey, . .	22.85	22.85	823	737	703	—	—	—
Mt. Washington,	20.85	1.65	344	237	177	—	—	—
New Ashford,* .	13.44	13.44	195	178	160	—	—	—
New Marlboro',	40.50	38.90	1,647	1,649	2,037	+	23.53	23.68
Otis, . . .	38.61	1.11	1,018	956	855	—	—	—
Peru, . . .	24.58	7.32	487	494	443	+	—	—
Pittsfield, . .	35.74	35.74	6,501	9,676	12,267	47.30	26.78	88.69
Richmond, . .	15.84	15.33	970	944	1,141	—	20.87	17.63
Sandisfield, . .	52.50	1.12	1,615	1,411	1,172	—	—	—
Savoy, . . .	38.77	5.47	919	866	730	—	—	—
Sheffield, . .	42.94	35.90	2,624	2,459	2,233	—	—	—
Stockbridge, . .	20.01	20.01	2,058	1,967	2,089	—	6.20	+
Tyringham, .	16.50	16.50	710	650	517	—	—	—
Washington, .	40.14	26.70	1,008	859	603	—	—	—
W. Stockbridge,	15.08	15.08	1,763	1,620	1,981	—	22.28	12.37
Williamstown, .	50.26	50.26	2,529	2,555	3,683	+	44.15	45.24
Windsor, . .	37.73	12.30	905	753	624	—	—	—
	894.34	594.06	52,791	56,944	68,265	7.87	19.85	29.31

The table shows that only seven towns have added one-fifth or more to their population in twenty years, and it is hardly likely that others than North Adams and Pittsfield will ever become large cities, — if indeed these two ever do, — a fact which will be of some importance in considering the present and future pollution of the streams in Berkshire County.

Water-Supply and Sewerage.

North Adams, South Adams, Cheshire, Pittsfield, Lenox, Stockbridge, Williamstown, and Great Barrington have pure public water-supplies, which, with possibly the exception of Lenox, where other springs may be brought into requisition, may be made to fill all demands of an increasing population, without being dependent upon the Hoosac and Housatonic Rivers, the waters of which are rather hard for domestic use.

None of the towns, except, Lenox, have sewerage systems, although there are some sewers in North Adams, South Adams, Pittsfield, and Great Barrington. The mills are therefore the chief sources of pollution, but not often to a troublesome extent; and the water below them is not used for domestic purposes.

Pollution in the County.

The principal business of the mills in this county is the manufacture of woollens, cottons, and paper; and their refuse, especially lime and soap, is distinguishable by the unaided senses for only short distances, in streams containing large quantities of inorganic matter. At the present time the pollution of the Hoosac and Housatonic Rivers, although in some places injuring the water for certain manufacturing purposes, is not such as to cause offence; and it can hardly be said to injuriously affect the public health, unless possibly indirectly in Dalton, by adding to the injurious influences of the miasm from the beds of the mill-ponds laid bare at times during the summer and autumn months.

There is no case, with the exception of Dalton, where a nuisance in one town is clearly attributable to pollution of the stream occurring in another.

The Housatonic Basin.

The notes and tables of Mr. E. K. Clark, C.E., are now given, as prepared during the past summer.

The East Branch of the Housatonic River rises in Hinsdale and Peru. The entire stream shows the lime character of the hills at its source. Through the village of Hinsdale, the water is used by four woollen-mills employing 385 hands, where a large quantity of wool is washed and manufactured, the refuse from which, including the human excrement, is discharged into the river. The volume of water is not large, although the fall is quite rapid, and the water is colored by dyestuffs, &c., for quite a distance below the village, which has about 1,000 inhabitants. It would be hardly possible for the village sewage to reach the river.

At Dalton, there are one cotton, two woollen, and four paper mills, in all employing 630 hands. At the upper or cotton mill, the water is considerably discolored from the refuse of the Hins-

dale woollen-mills, although between these points the river has a rapid fall for one and one-half miles. The woollen-mills find the water in good enough condition for their manufacturing purposes, but the paper-mills below them are obliged to use spring or Artesian-well water, particularly for their fine grades of paper. The refuse of all kinds from most of these mills is allowed to go into the water; in some few cases, however, the liquids only are discharged. The village of Dalton has a small population, with no direct sewage connection with the river; the soil is sand and gravel, and the rock of a lime character. A rapid stream from Windsor joins the river in Dalton. At Windsor, the population is small, and the water-power is used by saw and grist mills.

On the river in Pittsfield, are a tannery, paper-mill, and cotton-mill. The pollution from the latter is nothing, as they use the water only for power. The solid refuse from the tannery is saved, as it is valuable for manure; the water in which hides are washed, and the liquids from vats, are allowed to go into the stream. The gas-works, a little below, allow some liquids to escape, the effect of which can be seen on the surface of the water; but it is the intention usually to dispose of the coal-tar in another way. The town proper has about 9,000 inhabitants, and is supplied with water from a lake in Washington, which is used by about 600 families. No system of sewerage has been provided by the town; but one main sewer and two or three smaller ones, have been built, which discharge into the river below the village. There are from seventy-five to one hundred direct connections with these, but cesspools are largely used.

The West Branch of the Housatonic River is formed by the junction of three streams; on the first, coming from Onota Lake, there are two woollen-mills, and one cotton-mill, employing 280 hands; the water is discolored at times, below the lower mill, from which all the refuse and excrement are discharged into the stream. The second branch, from Pontoosac Lake, affords power for three woollen-mills with 485 hands; all washings and waste from manufacturing are discharged into the water, which is much discolored at times; the tenement houses usually discharge their sewage into boxes, the contents of which are removed two or three times a year. The water of these two streams united supplies power to two woollen-mills, and, although a little dark, does not seem to be in bad condition. The third or main stream, arising in Richmond and in the western part of Pittsfield, has upon it five woollen-mills within a distance of two or three miles, which give employment to 346 hands; these are not large, but all scour and dye

wool, allowing their refuse, including excrement, to pass into the water. The effluent water is considerably discolored; but when the stream joins the East Branch, a little below the town, it is in a very fair condition. Lime rock is abundant at the heads of all three of these tributaries.

From Pittsfield, through Lenox, the water has such a gradual fall for six or seven miles, that it is not valuable for power. It is next used by a paper-mill in Lee, which turns the lime and chloride of lime washings into the stream. At Lenox Furnace, there are a glass-factory, and an iron-furnace; the pollution from these and from the small settlement at this point is very slight. The principal village of Lenox would naturally drain into the river by a stream which flows through Stockbridge. Its population is largely increased during the summer. Water has been introduced from a spring near the village, which has sufficient height to reach every house. The drainage from the village would not be enough, under ordinary circumstances, to give trouble, neither would it pollute the stream to any perceptible degree; but with the introduction of water, a system of sewerage has been adopted, with which seventy families made plans to make connections. The object aimed at was to get the sewage out of the village, and at the same time not discharge it into a running stream. The method, as devised and carried out by Col. Waring, is to lay smooth drain-pipes in the principal streets, at inclinations of about one in two hundred, arranged so that they can be frequently flushed. These pipes convey the house-drainage to a large flush tank, of Mr. Rogers Field's patent, on the upper side of a field, a short distance from the village. The outlet of this tank is a siphon, which connects with a system of two-inch porous drain-tiles, which are laid in lines about six feet apart on the side of the hill, at a depth of about one foot. The tank is supposed to hold the sewage of about two days, and, when full, discharges itself quickly into the small pipes through which it gradually soaks into the soil. In the interval of two days which follows the discharge, the pipes and soil are made ready for the next flushing. So far the system seems to have accomplished its purpose.

The river fall here is quite gradual, and the power is next used by a paper-pulp mill; but, as no chemicals are used in producing this pulp, the river is not damaged by it.

In the southern part of Lee there are five paper-mills, within a short distance of each other. The principal part of their refuse, which consists of the water in which rags are washed with lime and chloride of lime liquids, goes into the river; and these impuri-

ties are noticeable at short distances below the mills. South Lee has a population of seven or eight hundred, but no system of water supply or drainage. The power of the river is used by another paper-mill, a short distance below the village, and the water is considerably discolored at times as it leaves this mill.

In Stockbridge there is a woollen-mill employing 120 hands, where considerable quantities of wool are washed daily. The liquids are allowed to go into the river, but all solid refuse is kept out.

The small stream which flows through the centre of Stockbridge joins the river below this woollen-mill. Upon this stream there are four wood-pulp mills, and one small flock-mill; the latter may pollute the stream to a slight extent with dye-liquors, the former scarcely any. The soil along the stream is sandy, and the rock lime. A small stream, which has its rise partly in Tyringham and partly in Lee, has a very rapid fall till it joins the river here; there are eleven paper-mills on this stream within a distance of two miles, all using the water for manufacturing purposes, but not employing many hands, and the impurities are quite marked. There is a small paper-mill on the river, below its junction with the stream above mentioned, manufacturing principally Manilla paper. Lime and chloride of lime are not largely used. With the exception of a few tenement houses near the woollen-mill and the last-named paper-mill, the village of Stockbridge has no direct drainage to the river; but the surface-drainage may carry a slight amount of impurity. The river has now a flow of nearly two miles, before it is again used for manufacturing purposes; then it is employed by two large cotton-mills, in connection with which there is a coloring establishment, which pollutes the river to some extent. The paper-mill, a short distance below this mill, is obliged to use spring water principally for manufacturing, the river water being too impure for that purpose.

Williams River rises in Richmond, and, flowing through West Stockbridge, joins the main river in Great Barrington. Considerable quantities of iron ore are mined near the source of this stream. The rocks are principally limestone. The power of the stream is used by a small paper-mill, at Williamsville, by one or two saw and grist mills, and also by an iron-foundry, near the point where it joins the main river; but these do not pollute the water to any appreciable degree. At Great Barrington village there is a large woollen mill, employing 200 hands, the refuse from which, with the excrements, goes directly into the river. The effluent water is usually discolored. This village has a population of about 2,700, and is

supplied with aqueduct water from a small pond near the town: 271 families use this water for domestic purposes, one-tenth of this number having water-closets. No system of sewerage has been organized; but one or two small brick and pipe sewers, and one of larger size in the main street, discharge into the river at convenient points. Sixty-five families connect with these sewers. The gas-works here are not extensive, but they discharge some liquids and tar into the water, of which farmers below the village have made complaints at times, but not recently. Most of the tar is carried away from the river. From Great Barrington to the State line, the river has not fall enough for manufacturing purposes; and, as the villages in Sheffield are quite small, the amount of pollution is but slight.

Mill River joins the Housatonic outside of the State. It has a rapid flow, and in New Marlborough affords power to four paper-mills, not now in operation. The rock at its source is lime.

The point S′ on the map indicates the place at which it is proposed to discharge the sewage of a portion of the town, when the sewerage of Pittsfield is completed.

A discontinued tannery in Hinsdale, gas-works for some of the mills in Pittsfield, and an unfinished mill in Great Barrington, are not in the table, although appearing on the map.

TABLE II.—*Mills, Factories, &c., in the Housatonic Basin.*

NAME OF RIVER OR STREAM.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	Head and Fall in Feet.	No. of Spindles.	No. of sets of Machinery.	No. of hands employed.	Quantities of Materials used per Year as far as known, &c.
E. Br. Housatonic,		Woollen, .	Hinsdale, . .	24	–	5	100	Wool stock, 750,000 lbs.; logwood, 100 tons; soap, 45 tons: soda ash, 7 tons; blue vitriol, 6 tons; copperas, 25 tons; sumac, 25 tons.
E. Br. Housatonic,		Woollen, .	Hinsdale, . .	16	–	9	125	Logwood, 12 tons; use some vitriol, soda ash, and indigo; 22,500 lbs. soap.
E. Br. Housatonic,		Woollen, .	Hinsdale, . .	24	–	5	100	Wash and scour wool.
E. Br. Housatonic,		Woollen, .	Hinsdale, . .	19	–	3	60	Wash and scour wool ; also do some dyeing.
E. Br. Housatonic,		Cotton, .	Dalton, . .	20	3,190	–	30	Stock, 208,000 lbs.
E. Br. Housatonic,		Woollen, .	Dalton, . .	23	–	5	80	Stock: 225,000 lbs. wool ; logwood, 1,400 lbs. ; chloride of lime, 1,400 lbs. ; soap, 8,000 lbs. ; sal soda, 1,000 lbs. ; soda ash, 6,000 lbs.
E. Br. Housatonic,		Paper, . .	Dalton, . .	23	–	–	200	Paper stock, 900 tons ; chloride of lime, 105,000 lbs. : lime, 1,200 bls.
E. Br. Housatonic,		Woollen, .	Dalton, . .	25	–	5	100	Wool stock, 240,000 lbs.
E. Br. Housatonic,		Paper, . .	Dalton, . .	26	–	–	130	Paper stock, 600 tons ; chloride of lime, 12,000 lbs. ; alum, 600 lbs.
E. Br. Housatonic,		Paper, . .	Dalton, . .	14	–	–	40	Paper stock, 90 tons (linen stock) ; chloride of lime, 5,600 lbs.
E. Br. Housatonic,		Paper, . .	Dalton, . .	20	–	–	50	Clean paper stock, 600 tons ; chloride of lime, 15,000 lbs ; lime, 300 bls. ; alum, 500 lbs.
E. Br. Housatonic,		Paper, . .	Pittsfield, . .	12	–	–	38	Paper stock, 900 tons ; chloride of lime, 10,000 lbs. ; lime, 300 bls.
E. Br. Housatonic,		Tannery, .	Pittsfield, . .	–	–	–	30	10,000 hides (tanned) ; use lime.
E. Br. Housatonic,		Gas Works,	Pittsfield, . .	–	–	–	5	1,020 tons coal.

E. Br. Housatonic,		Cotton, .	Pittsfield, . .	14	3,600	–	100	Stock, 432,000 lbs.
Onota Lake Stream,		Woollen, .	Pittsfield, . .	22	–	5	40	
Onota Lake Stream,		Cotton, .	Pittsfield, . .	33	4,700	–	75	
Onota Lake Stream,		Woollen, .	Pittsfield, . .	21	–	9	165	Wool stock, 475,000 lbs. ; logwood, 100,000 lbs. ; sal soda, 25,000 lbs. ; soda ash, 12,000 lbs. ; soap, 90,000 lbs.
Pontoosuc Stream, .		Woollen, .	Pittsfield, . .	33	–	12	250	Wool stock, 780,000 lbs. ; logwood, 24 tons ; sal soda, 6 tons ; soap, 30 tons.
Pontoosuc Stream, .		Woollen, .	Pittsfield, . .	26	–	–	–	Not in operation.
Pontoosuc Stream, .		Woollen, .	Pittsfield, . .	24	–	8	235	Wool stock, 450,000 lbs.; logwood, 30 tons; sal soda, 5 tons; soda ash, 6 tons ; soap, 15 tons.
Pontoosuc Stream, .		Woollen, .	Pittsfield, . .	14	–	–	–	
Pontoosuc Stream, .		Woollen, .	Pittsfield, . .	8	–	–	250	
W. Br. Housatonic,		Woollen, .	Pittsfield, . .	12	–	3	40	
W. Br. Housatonic,		Woollen, .	Pittsfield, . .	11	–	4	51	Wool stock, 120,000 lbs ; soap, 12,000 lbs.
W. Br. Housatonic,		Woollen, .	Pittsfield, . .	16	–	3	45	
W. Br. Housatonic,		Woollen, .	Pittsfield, . .	12	–	9	125	
W. Br. Housatonic,	A	Woollen, .	Pittsfield, . .	14	–	4	85	Wool stock, 100,000 lbs. ; logwood, 60,000 lbs. ; soda ash, 15,000 lbs. ; sal soda, 7,500 lbs. ; soap, 21,000 lbs.
Housatonic, . .		Paper, . .	Lee, . . .	12	–	–	50	Paper stock, 1,300 tons ; use chloride of lime, &c.
Housatonic, . .		Paper, . .	Lee, . . .	12	–	–	8	Manufacture wood pulp.
Housatonic, . .		Paper, . .	Lee, . . .	15	–	–	75	Paper stock, 1,800 tons; chloride of lime, 60,000 lbs.; lime, 300 tons.
Housatonic, . .		Paper, . .	Lee, . . .	10	–	–	125	Paper stock, 3,750 tons ; use chloride of lime, &c.
Housatonic, . .		Paper, . .	Lee, . . .	8	–	–	75	Paper stock, 2,600 tons ; use chloride of lime, &c.

TABLE II.—*Mills, Factories, &c., in the Housatonic Valley.*—Concluded.

NAME OF RIVER OR STREAM.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	Head and Fall in Feet.	No. of Spindles.	No. of Sets of Machinery.	No. of hands employed.	Quantities of Materials used per Year so far as known, &c.
Housatonic, . .		Paper, . .	Lee, . . .	19	–	–	125	Paper stock, 900 tons : use chloride lime, &c.
Housatonic, . .		Woollen, .	Stockbridge, .	14	–	7	120	Wool stock, 240,000 lbs. ; logwood, 40,000 lbs. ; soda ash, 1,500 lbs. ; sal soda, 1,500 lbs. ; soda, 1,500 lbs.
Housatonic, . .		Paper, . .	Stockbridge, .	18	–	–	15	Paper stock, 450 tons ; use small quantity chloride of lime.
Housatonic, . .		Cotton, } .	Gt. Barrington, .	18	10,000	–	200	Stock, 210,000 lbs; stock coloring, and use logwood.
Housatonic, . .		Cotton, } .	Gt. Barrington, .	9	–	–	–	
Housatonic, . .		Paper, . .	Gt. Barrington, .	10	–	–	130	Paper stock, 450 tons; use chloride of lime, &c.
Goose Pond Stream,		Paper, . .	Lee, . . .	40	–	–	11	Manufacture Manilla paper.
Goose Pond Stream,		Paper, . .	Lee, . . .	40	–	–	15	
Goose Pond Stream,		Paper, . .	Lee, . . .	37	–	–	2	
Goose Pond Stream,		Paper, . .	Lee, . . .	40	–	–	19	
Goose Pond Stream,		Paper, . .	Lee, . . .	30	–	–	8	
Goose Pond Stream,		Paper, . .	Lee, . . .	40	–	–	35	
Goose Pond Stream,		Paper, . .	Lee, . . .	24	–	–	8	Paper stock, 180 tons; chloride of lime, 15,000 lbs.
Goose Pond Stream,		Paper, . .	Lee, . . .	24	–	–	12	Paper stock, 195 tons: chloride of lime, 20,000 lbs.

Goose Pond Stream,		Paper, . .	Lee, . . .	14	–	–	20	Paper stock, 120 tons; chloride of lime, 15,000 lbs.
Goose Pond Stream,		Paper, . .	Lee, . . .	14	–	–	18	Paper stock, 150 tons; use some chloride of lime.
Goose Pond Stream.		Paper, . .	Lee, . . .	14	–	–	20	Paper stock, 150 tons; chloride of lime, 15,000 lbs.
Goose Pond Stream,		Cotton, .	Lee, . . .	14	–	–	–	Not in operation.
Curtisville Stream,		Wood Pulp,	Stockbridge, .	30	–	–	3	
Curtisville Stream,		Wood Pulp,	Stockbridge, .	18	–	–	2	
Curtisville Stream,		Wood Pulp,	Stockbridge, .	13	–	–	2	
Curtisville Stream,		Wood Pulp,	Stockbridge, .	12	–	–	3	
Curtisville Stream,	B	Flock, . .	Stockbridge, .	9	–	–	7	Scour wool.
Williams River, .		Paper, . .	W. Stockbridge,	12	–	–	12	Manufacture Manilla paper.
Housatonic, . .	C D	Woollen, .	Gt. Barrington,	12	–	10	200	Wool stock, 400,000 lbs.; soap, 40 tons; logwood, 50 tons.
Mill River, . .		Paper, .	New Marlboro',	25	–	–	–	
Mill River, . .		Paper, .	New Marlboro',	15	–	–	75	Not in operation at present (June, 1877).
Mill River, . .		Paper, .	New Marlboro',	16	–	–	–	
Mill River, . .	E	Paper, .	New Marlboro',	24	–	–	75	Not in operation at present (June, 1877).

The mills, generally speaking, discharge their refuse, including the house offal from tenements in some cases, directly into the streams; but there is very little serious pollution, except from some of the woollen and paper manufactories. The dye-stuffs from the former (in Barrington) discolor the water, but do not otherwise do much harm; in Hinsdale, together with the scourings from the wool and the refuse from the privies, they render the stream unfit for the manufacture of the nicer grades of paper, lower down, in Dalton. In Pittsfield the woollen-mills pollute the stream somewhat, but it soon becomes clear again; the washings, &c., from the paper-mills of Lee are noticeable for only a short distance, especially so where there is as much lime in the river as there is in the Housatonic basin; while a mile below the lowest mill on the river in this State, it would be impossible to tell by the eye that any serious pollution had taken place. For all that, most of the manufacturers of the best grades of paper are obliged to depend upon springs, wells, &c., for their pure water-supply.

The river is rather rapid in its fall, and the fouled water quickly loses its unsightly appearance. Human excrement, the sewage proper of towns, is so stored up in privies and cesspools, often too seldom emptied and disinfected, that the river receives comparatively little harm from that source.

The summaries of the statistics appear in the following two tables: —

TABLE III. — *Summary of Manufactories.*

	Number.	Operatives employed.
Woollen Mills,	20	2,178
Cotton Mills,	6	405
Paper Mills,	34	1,401
Tannery,	1	30
Gas Works,	1	5
Total,	62	4,019

TABLE IV. — *Summary of Statistics for Certain Points on the Housatonic River.*

	A	B	C	D	E
Drainage area above point indicated, in square miles, . . .	150	280	368	428	74
Dry-weather flow at respective points in 24 hours, cubic feet, .	3,240,000	6,048,000	7,948,800	9,244,800	1,598,400
Dry-weather flow at respective points in 24 hours, U. S. gallons, .	24,300,000	45,360,000	59,616,000	69,336,000	11,988,000
Number of factories or mills above point indicated, . . .	26	54	56	56	4
Number of polluting factories or mills per square mile, . .	0.17	0.20	0.15	0.13	0.05
Number of operatives in said mills, ...	2,549	3,657	3,869	3,869	150
Population above respective points in 1865, ...	13,879	22,361	28,907	32,281	2,386
Population above respective points in 1875, ...	17,137	25,811	34,159	37,203	2,740
Population above respective points per square mile, . . .	114	92	93	87	37
Population of cities, villages, and mills sewering into river above said points	10,234	13,384	15,774	16,109	761
Population of this character per square mile, ...	68	48	43	37	10

General Survey.

In the high lands of Peru and Windsor, with a shallow soil overlying the rock, the wells and vaults in suspicious proximity, typhoid fever is common. Lower down on the stream, in Hinsdale, with similar conditions except that the soil is deeper and therefore a more thorough disinfectant, typhoid is comparatively rare; while still farther down the valley, in parts of Dalton, where the bed of the river is elevated by dams, much of it often bare in summer, and polluted by the refuse of the woollen-mills, but also always with insanitary local conditions, typhoid fever has been extremely rife.

In Pittsfield, more complete sewerage is needed very much; but with the example of Dalton before them, and, in fact, with a similar experience from the foul beds above one of their own dams, it is not likely that the town will introduce sewerage until they can carry their outlet below the lowest dam, and so avoid all danger of nuisance and disease.

The sewerage system,[1] so admirable for private houses having a few hundred feet square of lawn, which has been introduced by Col. Waring in Lenox, and described by Mr. Clark on page 11 of this Report, has not been in fair operation, as so few houses have connected with it; but the hotel and many of the boarding-houses and dwellings are so improperly provided with drainage at present, that they will probably find it necessary to do so at once, in order to secure themselves in a satisfactory manner from just complaint; and the system seems to promise well under certain conditions of sufficient land, &c., for small towns and public institutions as well as for private residences and tenements.

In Lee there is a project to introduce a pure water-supply; and that will necessitate sewers immediately or soon after. Both can be done without great cost. In this town, just to the south of Laurel Lake, typhoid fever has prevailed in a small collection of houses, when the lake is low; but only since the removal of a belt of trees has exposed them directly

[1] This is described on pp. 94 *et seq.*, of VILLAGE IMPROVEMENTS AND FARM VILLAGES, by G. E. Waring, Jr. Boston: James R. Osgood & Co., 1877; also in previous reports of this Board, and in the "American Agriculturist" for October, 1877.

to emanations from the exposed bank and bed of the lake. In the latter part of the summer this exposed portion is of considerable area, as the water is largely drawn off for manufacturing purposes.

In Stockbridge, where the river is wide and somewhat sluggish, it is the opinion of competent medical gentlemen that the exposed and bare banks of the stream gave rise to typhoid fever, when polluted by the refuse of two large tanneries, — an evil which is thought to have so far disappeared with the removal of the most objectionable source of pollution, that outbreaks now are traced to more purely local causes.

Natural Drainage.

In parts of Lenox, Stockbridge, and Great Barrington, and through Sheffield, the fall of the river is too slight for mill-privileges. Elsewhere the descent is rapid, as may be seen by referring to the figures on the map. The valley of the Housatonic is composed of limestone, with an alluvium of sand, gravel, and loam, in which clay comes, here and there, to the surface. On the east, taking in parts of the smaller towns, the gneiss of the White Mountains group extends through the basin, including the Hoosac range; on the west, the schists of the paleozoic group skirt along the western edge of the State, and send a belt through portions of Cheshire and New Ashford, which widens so as to embrace a great part of Adams; the limestone appears, however, in a narrow strip through the centre of Hancock, following Kinderhook Creek into New York State and Green River northwards, broadening, too, so as to occupy the greater part of Williamstown. Quartz and mica appear in parts of Great Barrington, Sheffield, and Tyringham.

The natural drainage of the Housatonic basin, therefore, may be said to vary very much in different localities, which may be conveniently placed in two groups.

First, come the hill-towns, sparsely populated, with a shallow soil overlying the hard rock of the eozoic and paleozoic groups. Water runs rapidly from the surface of these hills, carrying down with it the softer and more friable soil, leaving behind the clay and harder loams. The subsoil drainage, however, is often bad, as the hard underlying rocks prevent

the deep moisture from still further disappearing. We have, therefore, in such cases, a damp subsoil concealed under an apparently dry surface. The effect of this condition would be likely to appear in the mortality from diseases produced or favored by soil moisture, of which pulmonary consumption is the chief; and this fact is strikingly exemplified by the death-rates for the ten years ending in 1865, as shown by the late Dr. Derby in his paper on Consumption, in the Massachusetts Registration Report for 1865. The order of mortality from pulmonary diseases was there given for the then 334 cities and towns in the State. Those of the Housatonic basin are reproduced here, by which it will be seen that, generally speaking, the fatality from consumption was greatest in the hill-towns and least in the valley, — in spite of the sparseness of the population and purity of the air in the former. The inhabitants of these smaller hill-towns are not so well supplied with the comforts of life, however, as their neighbors in the more fertile valleys, and generally have to send to a neighboring town for medical assistance in case of sickness, so that acute diseases are neglected and become chronic. These two causes would, of course, tend to increase their death-toll from chronic complaints; and that this fact is generally true, although the order of the towns by their mortality may not be exact, is confirmed by medical experience. Dr. Sabin of Williamstown, in making examinations for the army during the recent war, also found the people of the hill-towns, to a striking degree less strong than those of the valley, and there were more invalids among them. Their registration of causes of death, however, may be less accurate; but making all these allowances, it would appear that pulmonary consumption is more fatal in them, if the registration is at all to be depended upon.

Typhoid fever, too, is said by the physicians generally to be much more prevalent in these hill-towns, where the shallow soil, with a hard rock bottom, only hastens the probability of well infection from the .privies, stables, pig-pens, and sink-spouts so frequently placed in close proximity.

Table V. — *Relative Mortality from Consumption in the Towns of the Housatonic Basin.*

NAMES OF TOWNS.	Order of Mortality in the Housatonic Basin.	Order of Mortality in the State.
Mount Washington,[1]	1	1
Hancock, ...	2	7
Windsor, ...	3	10
Richmond, ...	4	11
Alford, ...	5	22
Washington, ...	6	35
Peru, ...	7	43
Lanesborough, ...	8	44
New Marlborough, ...	9	49
West Stockbridge, ...	10	59
Egremont, ...	11	65
Monterey, ...	12	66
Stockbridge, ...	13	81
Great Barrington, ...	14	87
Dalton, ...	15	98
Pittsfield, ...	16	108
Lee, ...	17	124
Lenox, ...	18	184
Sheffield, ...	19	221
Hinsdale, ...	20	283
Tyringham, ...	21	302

Secondly, The valley towns, on dry alluvial overlying limestone, having admirable natural drainage, excepting in some spots where the clay comes nearly or quite to the surface, and in a few instances where the construction of mill-dams, by a considerable elevation of the level of the ground water, has caused increased dampness in neighboring cellars and adjacent soil. These towns are so favorable to health that Berkshire County, as a whole, including this (the Housa-

[1] There is some error in regard to this town; for it contains only 603 inhabitants, and is quite a resort for consumptives from some of the large cities. As the population is so small, even a single death belonging to another place, and registered here, would seriously affect the rate, and place Mount Washington much higher in the list than it really belongs.

tonic) and the Hoosac basins, had, by Dr. Derby's tables, the lowest relative death-rate from pulmonary consumption, of all the counties in the State, the least being 16.84 per cent of the total mortality and the greatest, 21.74 per cent.

Chemical Examinations.

Table VI. gives the result of the chemical examinations by Professor Nichols. For details of the methods employed, and the significance of the chemical examinations, the reader is referred to pages 174 and 266 of the seventh report, to page 50 of the eighth report, or to a paper by Prof. Nichols in this Report. It may be well, however, to call attention to the following points.

Organic and Volatile Matter.

The so-called organic and volatile matter is really the loss which the residue from the evaporation suffers when exposed to a low red heat. In the case of waters containing a small amount only of nitrates and chlorides and a small amount of carbonate of lime, this loss is mainly due to the destruction of the organic matter; but where the substances indicated are present in any considerable quantity, this loss is caused in part by the alteration of the mineral matter. In the examinations here recorded, the total solids were weighed after drying at 212° Fahr., and then ignited. The residue was moistened with water containing carbonic acid, and allowed to stand in order that the carbonates altered by heat might be re-formed, and the residue was again dried at 212°, and weighed.

Nitrates.

All natural waters contain traces of nitrates, not, however, as a rule in quantity sufficient to give indications of their presence, when the unconcentrated water is subjected to what is known as the "ferrous sulphate" test. If a water without concentration gives indications of nitrates by this test, it is quite certain evidence of previous contamination.

Hardness.

The hardness of the waters was estimated by the usual method, which consists in determining how much of a standard solution of soap is required in order to produce a permanent lather in a measured quantity of water. The hardness is caused mainly by the presence of the carbonates and sulphates of lime and magnesia; and the figures indicate the amount of carbonate of lime, or its equivalent, which is contained in 100,000 parts of the water.

TABLE VI. — *Examination of Water from Pittsfield and Lee.*

[Results expressed in Parts in 100,000.]

Number.	Date.	Locality.	Unfiltered Water. Ammonia.	Unfiltered Water. "Albuminoid Ammonia."	Filtered Water. Ammonia.	Filtered Water. "Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. "Organic and Volatile."	Solid Residue. Total at 212° F.	Chlorine.	Hardness.
1*	Oct. 31,	Reservoir, Pittsfield, . . .	0.0029	0.0107	0.0029	0.0104	7.1	0.8	7.9	0.22	–
2*	17,	Laurel Lake, ...	0.0109	0.0264	0.0169	0.0195	14.4	1.2	15.6	0.37	–
3*	Nov. 15,	" "	0.0243	0.0163	–	–	12.3	1.6	13.9	0.34	–
4*	Oct. 31,	a, as indicated on the map, .	0.0045	0.0227	0.0051	0.0184	9.9	2.0	11.9	0.27	7 00
5*	31,	b, " " . .	0.0120	0.0232	0.0120	0.0213	9.5	2.1	11.6	0.34	6.00
6*	31,	c, " " . .	0.0051	0 0240	0.0053	0.0181	11.4	2.0	13.4	0.39	7.00
7*	17,	d, " " . .	0.0099	0.0352	0.0099	0.0339	10.7	2.4	13.1	1.26	–
8*	17,	Pittsfield Sewer, ...	0.3630	0.1003	0.3630	0.0608	19.5	4.4	23.9	2.63	–
9*	17,	" "	0.7150	0.1408	0.7150	0.0843	18.5	7.1	25.6	3.13	–
10†	17,	Well in Pittsfield, ...	0.0043	0.0080	–	–	11.7	1.0	12.7	0.76	–
11‡	17,	" "	0.0104	0.0141	–	–	38.4	6.8	45.2	5.19	–
12†	17,	Well in Lee, ...	0.0045	0.0107	0.0045	0.0101	32.7	1.7	34.4	1.98	–
13†	17,	" "	0.0048	0.0096	0.0048	0.0091	36.2	2.4	38.6	1.08	–
14‡	17,	" "	0.0075	0.0181	0.0075	–	75.2	9.0	84.2	5.49	–
15†	17,	" "	0.0061	0.0091	–	–	38 4	5.4	43.8	3.56	–
16*	Nov. 15,	" "	0.0069	0.0056	–	–	19.9	1.2	21.1	0.29	–
17†	15,	" "	0.0157	0.0168	–	–	100.9	6.0	106.9	20.86	–
18†	15,	" Lenox, ...	0.0067	0.0048	–	–	31.9	2.1	34.0	1.24	–

* No indication of nitrates; † fair indication of nitrates; ‡ good indication of nitrates, by means of ferrous sulphate, in unconcentrated water.

Pittsfield and Lee are the only points on the river where chemical analyses are important; and, indeed, in the latter-named town they were made rather with reference to the necessity of a better water-supply than of a serious condition of pollution of the river, which cannot properly be said to exist.

No. 1 is from the Pittsfield water-supply, on Ashley Brook, and very pure. Nos. 2 and 3 are from Laurel Lake, the intended source of supply of the town of Lee. The three, therefore, represent specimens of the head waters in their purity; but No. 2 was taken during a high wind, and both that and No. 3, at a time when a large part of the water had been drawn off for manufacturing purposes, leaving a considerable portion of the bed bare; a fact which probably accounts for the greater amount of ammonia than in the Pittsfield supply.

Nos. 4, 5, 6, and 7 are from the several localities of the river referred to on the map, and at the points of greatest pollution. They indicate an amount of contamination which cannot be considered injurious from a sanitary point of view.

Nos. 8 and 9 are of the sewage of Pittsfield, at the outlet S, the former taken Saturday afternoon and the latter Monday morning. They show the sewage to be quite dilute, and to be of about one-third the value per gallon of average London sewage.

Nos. 10 and 11 are from wells in Pittsfield. The former is from a well in the cellar of a boarding-house, the well being ten feet deep, five feet below the cellar-floor, and very near the sink-spout which leaks out on the surface. The soil is sandy. A child recently died of diphtheria in the house; and it has formerly been a typhoid-fever nest. The well undoubtedly receives some sewage indirectly; but it is, so far as chemical examination at the present time goes, quite equal to the average of well waters. From the present examination, it is not, therefore, possible to condemn it entirely; although it should be looked upon with suspicion as being in communication with sources of filth, and liable, at times, to contain considerable quantities of it. Under the circumstances detailed above, it can certainly be said that its use is not wholly safe. No. 11 is from a house near the preceding. The well is situated in a yard between two dwellings, about

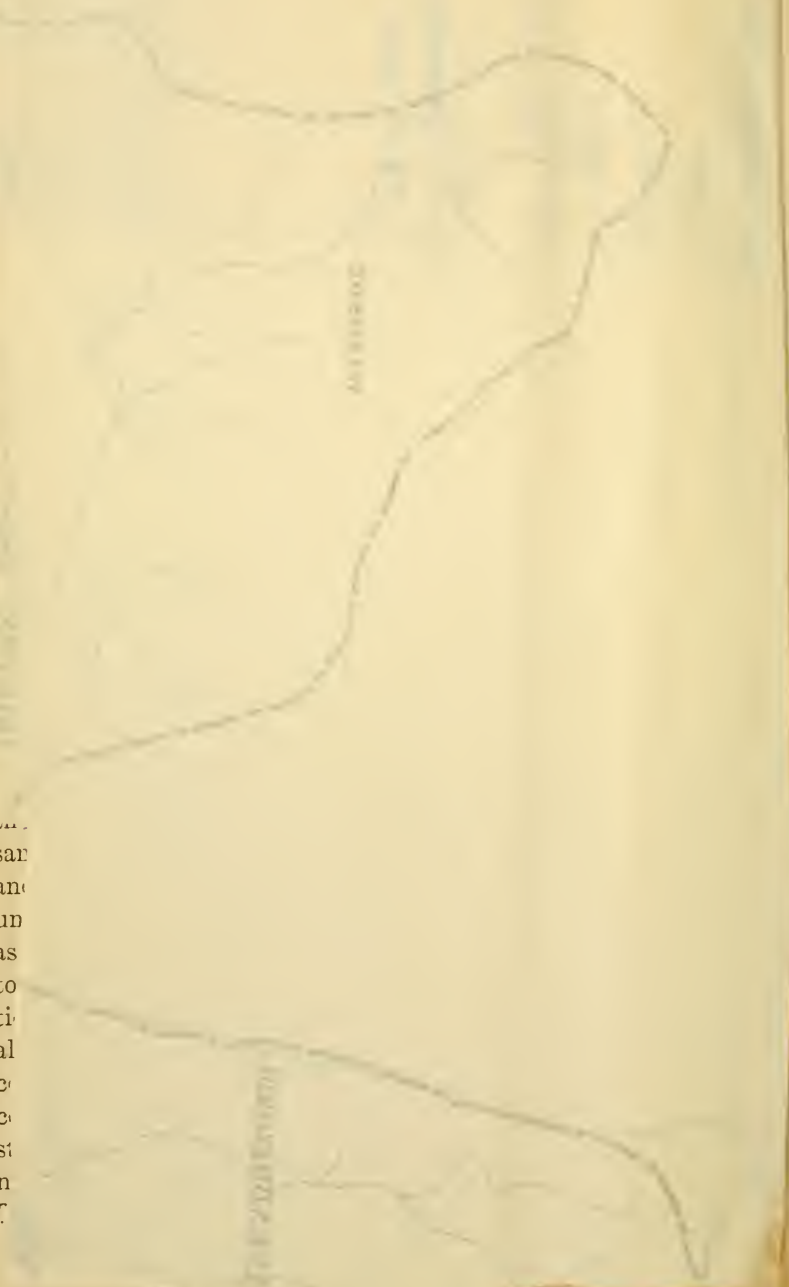
HOUSATONIC RIVER.

Drainage Area 428 Sq. Miles.

- • indicate Cotton Mills & Woolen Mills.
- □ " Paper Mills.
- △ " Tanneries.
- ▲ " Gas Works.
- " Head and Fall in feet.

2

c
r
r
(
(



th
sar
an
un
as
to
ti
al
c
c
st
n

30 feet from a barnyard. The well is ten feet deep, the water drawn by a pump. There is a case of diphtheria now in one of the houses using the well. It is unquestionably very bad, and its use should be discontinued.

Nos. 12–17 are from wells in Lee. No. 12 is situated 21 feet from a privy; but a close cement and brick vault, said to be water-tight, is used for the privy receptacle. There is no opportunity for surface drainage. The well has been recently cleaned; it is old, but well situated in other ways than as above. No. 13 is situated within 50 feet of two privies, which are frequently cleaned and well kept; it is also within 40 feet of the kitchen drain, which empties itself upon the surface, and is absorbed by the earth mainly, as there is almost no fall for its escape. These two (12 and 13) show evidence of "previous sewage contamination," and are to be regarded with suspicion, although not containing enough impurity to make us feel obliged to condemn them altogether. Still, the mere fact that the two do contain a certain amount of drainage from privies, renders it desirable to get a pure supply as soon as practicable. Another example of the failure of a cemented vault to secure a neighboring well from pollution, is given under Taunton in the Health of Towns of this Report. In such cases, the walls probably settle and crack, possibly by the action of frost.

No. 14 is from a well within 40 feet of a privy and barnyard, and within twenty feet of a horse-barn. The yard into which the offal of horses, a cow, and pig is emptied, is a basin which receives and holds the water for a long time after each rainfall: the privy empties itself into the same yard. It is not possible to see in this case how the well can escape contamination. Two fatal cases of diphtheria, almost the only cases that have occurred in this village during the past year, certainly the only cases of any severity, were on the place where this well is situated; and, previously to the examination of the water, the origin of the disease was to all a great mystery. No. 15 is within 50 feet of one privy and within 75 feet of another; but both are well kept. The two wells should be condemned, No. 14 being very bad indeed.

There has been no reason to suspect any of the above wells except No. 14, which is the only one where sickness usually

attributable, in part at least, to filth, has occurred in the family using it.

Of the remaining three, No. 16 is from a driven well and of some depth ; it is in the cellar of a new house, built two years ago, on a piece of land never before used for a dwelling, and very far removed from any source of contamination of long standing. Great care is taken of the premises ; the privy vault and drains are close. No. 17 is from an old well on the site of an old hotel in the centre of the town ; for three or four years it has not been at all protected from surface drainage. It is within 150 feet of the old hotel stable and privy — a vault in the earth. Within 50 feet of it was the old kitchen drain. There is no natural drainage about the place, and the whole soil must be contaminated. The well is within 20 feet of the present fish-market, and has probably not been cleaned for a dozen years.

No. 18 is from a well in Lenox, upon a well-kept place, at least 300 feet from the stable. Water-closets are used, and in respect of drainage every care is taken. The well does not seem to be protected from surface water, and is a very old one. The family have preferred this water to the public supply for the table, and have had some sickness this summer, that led Dr. Holcombe to make inquiries with respect to the water.

The Hoosac Basin.

The statistics of the Hoosac basin, also by Mr. Clark, are now given, accompanied by his notes.

The north branch of the Hoosac River rises in Vermont. The soil about the head waters is composed of sand and gravel ; the principal rock is lime, which noticeably affects the character of the water. The river receives a slight amount of pollution, in the form of tar and lime from chemical works at Stamford, Vt., where acid is manufactured by distillation from wood. This pollution is particularly noticeable, after a dry season, at the woollen-mill in Clarksburg. The water is used by the woollen-mill for manufacturing purposes, and the refuse, together with the excrements from the mill, is allowed to go into the river. The effluent water, though colored at times, gives no trouble to mills below. The amount of pollution from the village of Clarksburg is not enough to do harm, as the tenement houses do not drain directly into the river.

For a mile below Clarksburg, the river flows mostly over a rocky bed, and the power is next used by a cotton mill at North Adams. The land at this point is quite high on the side of the river; and the tenement houses, of which there are about 30, drain directly into the water, constituting the only source of pollution at that place. A woollen-mill, employing 70 hands, occupies the next privilege on the stream. Its effluent water is discolored at times, and that fact is noticeable at a cotton-mill about a quarter of a mile below. Print and bleachery works at North Adams are quite extensive, and the river-water is found to be in a sufficiently good condition for all their manufacturing purposes. The spent dyes, wash-water, and refuse are all turned into the stream, which is considerably discolored as it leaves the mill. Many of the tenement houses belonging to all of these mills drain directly into the river; some few discharge into cesspools.

The river is next used by a tannery, only a short distance below the print-works. The lime-water, and water in which hides are soaked and washed, run into the stream. The three cotton-mills below are owned and managed by one company. They employ about 200 hands, and the only refuse discharged into the stream is from the water-closets. Near the point where the north and south branches join, there are print-works employing 250 hands. They do not use the river as power, but take water for manufacturing purposes from the north branch. The refuse from these works goes into the stream, and discolors it considerably.

The south branch rises in Lanesborough and Cheshire. Upon Kitchen Brook there is a small tannery, polluting the water to a slight extent. The village of Cheshire has a population of about 1,100, and is supplied from a small tributary to Kitchen Brook, with water which is used by about seventy families. A few private sewers from the village discharge directly into the river. No public sewers have been built. The hills, which are quite high at the source of this branch of the river, are composed largely of limestone. The water seems naturally a little dark in color, probably from vegetable matter. In Cheshire, near the Adams line, is a cotton-mill, employing about 80 hands. Some surface drainage from tenement houses, with a small amount of tar from gas-works connected with the mill, goes into the water at that point. The power is next used by a cotton-mill, about half a mile below: the excrements from the 100 operatives employed there would be the principal source of pollution. Next below is a woollen-mill, where scouring and dyeing are done; and the stream is discolored for a short distance as it leaves this mill. A cotton-

mill, where some coloring is done, has the next privilege; spring-water is used in the dye-house, the river water being too impure. The effluent water is considerably discolored. The soil about this mill is gravelly, and the tenement-houses usually discharge into cesspools. The water is next used by a woollen-mill, where about 150 hands are employed. About half a mile below is a cotton-mill, where some coloring is done. The water is next used by a paper-mill, and about a quarter of a mile lower by another paper-mill; in these two paper-mills about 150 hands are employed. Spring-water is used in the process of manufacturing; and, as nothing but clean stock is used, the washings, although discharged into the stream, do no injury. A tannery, where 4,000 hides are tanned yearly, uses the power of the stream next. The refuse discharged consists of the liquid in which hides are washed, and lime-water from vats: the spent bark is used as fuel. A paper-mill, a quarter of a mile below, uses brook-water for manufacturing purposes: the refuse and excrements are discharged into the river. Next in order come the gas-works; and then, within a short distance of each other, are three cotton-mills, operated by one company, employing 750 hands in all. Considerable coloring is done at one of these, from which the water flows a good deal discolored.

South Adams has a population of about five thousand, and is supplied with water from one of the mountain streams. About five hundred families use this water. There are no public sewers; but a few pipes have been laid, which take the sewage of several families directly into the river. Most of the houses, however, drain into cesspools. The larger part of the town is situated on the hillside, inclining favorably toward the river for surface drainage to reach the stream. The gas-works are not extensive, consuming only about four hundred and fifty tons of coal per year. Some tar and wash water escape into the river.

Between South Adams and North Adams, — a distance of five or six miles, — the fall of the river is very gradual. At North Adams, there is a population of about nine thousand; and the river receives the surface drainage of the entire town. In four of the principal streets, pipe-sewers have been laid; and most of the hotels have direct sewers, all discharging into the river. No system of sewerage has been perfected. The gas-works there use about seven hundred tons of coal per year; and a small amount of wash water and tar go into the river. The town is well supplied from a mountain stream with water, which is used by nearly the entire town within the fire-district. The first privilege, after

The water-closets discharge into the river, but the tenement-houses are otherwise provided for. About one mile below, is a woollen-mill, employing 170 hands. The refuse from manufacturing and spent-dye liquors flow into the river. The drainage from the tenement-houses and the privies has its discharge into the river. Near this mill, a little stream joins the river, upon which there is a small establishment for making pyroligneous acid. A little tar goes into the stream from this manufactory. Three-quarters of a mile below is a large cotton-mill,[1] not yet in operation; and three-quarters of a mile lower still are the Blackinton woollen-mills, where 350 hands are employed; the effluent water is usually discolored; the tenement-houses empty all their sewage into a ditch which leads to the river.

The water is last used in the State by a cotton-mill at Williamstown; and there it seems in a very fair condition at high water, but in time of drought is quite discolored and turbid. Nowhere on the stream do cattle refuse to drink the water; and fish of the coarser kinds still continue to live in most parts of it. Williamstown has a population of about twenty-five hundred. Water has been introduced, and is used quite generally; but no system of sewerage is perfected. The Green River, which joins the Hoosac at Williamstown, has two small cotton-mills upon it. The water of this stream is very clear and pure. Below the mills, however, it looks bad throughout, but chiefly on account of coloring matters, which are not foul-smelling, or otherwise injurious in this locality.

[1] This mill, and another on the North Branch, not being in operation, are not on the map; but their head and fall are marked.

TABLE VII. — *Statistics of the Hoosac River Basin.*

Name of Stream.	Letter corresponding with letter on Map.	Description of Mill.	Location.	Head and Fall in Feet.	Number of Spindles.	Sets of Machinery.	No. of hands employed.	Quantities of Materials used per year, so far as known.
Kitchen Brook,		Tannery,	Cheshire,	10	–	–	5	Tan 2,500 hides.
So. Branch Hoosac,		Cotton,	Cheshire,	14	2,000	–	78	Cotton stock, 208,000 lbs.
So. Branch Hoosac.		Cotton,	Adams,	21	5,500	–	100	Cotton stock, 234,000 lbs.
So. Branch Hoosac,		Woollen,	Adams,	12	–	7	100	Wool stock, 364,000 lbs.; logwood, 30,000.
So. Branch Hoosac,		Cotton,	Adams,	16	3,000	–	60	Cotton stock, 364,000 lbs.; do some coloring, using principally logwood.
So. Branch Hoosac,	D	Woollen,	Adams,	14	–	8	140	Wool stock, 240,000 lbs.; use small quantities of logwood and soda ash.
So. Branch Hoosac,		Cotton,	Adams,	25	3,000	–	60	Cotton stock, 330,000 lbs.; color some yarn.
So. Branch Hoosac.		Paper,	Adams,	13	–	–	–	This and the following mill operated by one firm.
So. Branch Hoosac,		Paper,	Adams,	12	–	–	150	Paper stock, 2,400 tons, principally clean rags; chloride of lime, 25 casks; lime, 300 bbls.
So. Branch Hoosac,		Tannery,	Adams,	5	–	–	11	Tan, 4,000 hides; use considerable lime.
So. Branch Hoosac,		Paper,	Adams,	14	–	–	60	Paper stock, 450 tons; chloride of lime, 100 casks; some lime.
So. Branch Hoosac,		Gas Works,	Adams,	–	–	–	3	Do not use water power; consume 450 tons coal.
So. Branch Hoosac,		Cotton,	Adams,	15	4,300	–	150	This and the following two mills operated by one firm.
So. Branch Hoosac,		Cotton,	Adams,	20	17,000	–	570	Cotton stock, 1,638,000 lbs.; at the lower mills some coloring is done, using indigo, sumac, copperas, &c.
So. Branch Hoosac,		Cotton,	Adams,	9	1,730	–	16	

No. Branch Hoosac,		Acid Works,	Stamford, Vt., .	18	–	–	12	Manufacture 50,000 gallons pyroligneous acid.
No. Branch Hoosac,		Woollen, .	Clarksburg, .	28	–	7	120	Wool stock, 338,000 lbs.; logwood, 96,000 lbs.; soap, 31,200 lbs.; use some soda, and soda ash.
No. Branch Hoosac,		Cotton, .	Adams, . .	17	9,500	–	175	Cotton stock, 600,000 lbs.
No. Branch Hoosac,		Woollen, .	Adams, . .	18	–	4	70	Wool stock, 156,000 lbs.
No. Branch Hoosac,		Cotton, .	Adams, . .	38	13,000	–	125	Cotton stock, 572,000 lbs.
No. Branch Hoosac,		Print Works,	Adams, . .	10	–	–	213	Print, 15,750,000 yards; use some logwood, and about six tons redwood, some lime, and chloride of lime.
No. Branch Hoosac,		Tannery, .	Adams, . .	–	–	–	5	Do not use water power; tan 5,000 hides; pull some wool also.
No. Branch Hoosac,		Cotton, .	Adams, . .	24	–	–	–	This and the following two mills operated by one firm.
No. Branch Hoosac,		Cotton, .	Adams, . .	16	–	–	–	Cotton stock, 676,000 lbs.
No. Branch Hoosac,		Cotton, .	Adams, . .	14	14,500	–	200	These operatives and spindles are for all three mills.
No. Branch Hoosac,	C	Print Works,	Adams, . .	–	–	–	250	Do not use water power; print, 28,200,000 yards; chloride of lime, 20,800 lbs.
Hoosac, . . .	B	Cotton, .	Adams, . .	9	600	–	15	Cotton stock, 101,000 lbs.; manufacture cotton twine.
Hoosac, . . .		Gas Works,	Adams, . .	–	–	–	3	Do not use water power; consume 700 tons coal.
Hoosac, . . .		Cotton, .	Adams, . .	16	6,000	–	150	Cotton stock, 360,000 lbs.
Hoosac, . . .		Woollen, .	Adams, . .	26	–	9	170	Wool stock, 360,000 lbs.; soap, 18,200 lbs.; soda ash, 4,500 lbs.; sal soda, 12,000 lbs.; salt, 30,000 lbs.
Hoosac, . . .		Woollen, .	Adams, . .	14	–	18	300	Wool stock, 1,000,000 lbs.; scour and dye wool, using logwood, 364,000 lbs.; soap, 31,200 lbs.; soda ash, 104,000 lbs.; sal soda, 7,800 lbs.
Hoosac, . . .		Cotton, .	Williamstown, .	14	6,000	–	300	Cotton stock, 585,000 lbs.
Green River, . .		Cotton, .	Williamstown, .	9	100	–	20	Cotton stock, 78,000 lbs.
Green River, . .		Cotton, .	Williamstown, .	18	4,500	–	80	Cotton stock, 182,000 lbs.
Notch Brook, . .	A	Acid Works,	Adams, . .	–	–	–	2	Do not use water power; manufacture 45,000 gals. pyroligneous [acid.

TABLE VIII. — *Summary of Statistics of the Hoosac River Basin.*

	A	B	C	D
Drainage area above point indicated in square miles,	228	129	49	38
Dry-weather flow at respective points in 24 hours, cubic feet,	4,924,800	2,786,400	1,058,400	820,800
Dry-weather flow at respective points in 24 hours, U. S. gallons,	36,936,000	20,898,000	7,938,000	6,156,000
Number of polluting factories or mills above point indicated,	34	26	12	6
Number of polluting factories or mills per square mile,	.15	.20	.24	.13
Number of operatives in said mills,	3,713	2,688	1,185	483
Population above respective points in 1865,	13,366	9,810	1,530	1,812
Population above respective points in 1875,	22,136	16,717	2,670	1,863
Population above respective points per square mile,	97	130	54	49
Population of cities, villages, or mills, sewering into river above said points,	9,660	6,890	1,220	550
Population of this character per square mile,	42	53	25	14

TABLE IX. — *Summary of Manufactories.*

KIND OF MILLS.	Number.	Operatives Employed.
Cotton,	17	2,099
Woollen,	6	900
Paper,	3	210
Tanneries,	3	21
Gas Works,	2	6
Acid Works,	2	14
Print Works,	2	463
Totals,	35	3,713

In this basin, cotton manufactures form the chief business, while woollen comes next in importance; the three paper-mills in South Adams do almost no scouring, and use for bleaching, &c., a considerable amount of lime, which, being largely insoluble, does not seriously pollute the stream. Dye-stuffs pollute the north branch of the river, so that it is very unsightly, but not foul-smelling, when low.

The flow is rapid through the village of South Adams, where the water is quite clean a quarter of a mile below the lower mill; it becomes sluggish thence to North Adams, where there is considerable fall, but less than in South Adams; towards the lower part of North Adams, the sewage of a small part of the town mingles with the mill-refuse above one of the dams: but a mile lower there is to the eye scarcely a trace of pollution. In Williamstown, there is a foul deposit from the mills about the mouth of Green River, but the stream, although turbid there, soon becomes of very fair appearance again.

Chemical Examinations.

Seven specimens only were taken, and those when the river was extremely low, with the mills in full operation. They illustrate the character of the water from the upper part of South Adams, at intervals, down to the State line. The various localities are referred to points marked on the map. Table X. gives the results of the chemical examinations by Professor Nichols.

TABLE X. — *Examination of Water from Hoosac River.*

[Results expressed in parts in 100,000.]

Date Received.	Locality,	Unfiltered Water.		Filtered Water.		Unfiltered. Solid Residue.			Filtered. Solid Residue.			Chlorine.	Hardness.
		Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° F.	Inorganic.	"Organic and Volatile."	Total at 212° F.		
Sept. 15, .	D . .	0.0059	0.0197	0.0059	0.0195	7.8	5.8	13.6	–	–	11.7	0.53	6.3
15, .	d . .	0.0053	0.0264	0.0053	0.0163	17.9	5.8	23.7	–	–	16.2	0.33	7.6
15, .	B . .	0.0064	0.0709	0.0064	0.0349	16.3	6.8	23.1	–	–	16.1	0.59	8.6
14, .	b . .	0.0056	0.0243	0.0056	0.0192	12.2	5.1	17.3	11.9	3.8	15.7	0.64	8.5
14, .	a . .	0.0067	0.0288	0.0067	0.0221	14.5	2.9	17.4	14.4	2.8	17.2	0.53	8.8
14, .	a . .	0.0077	0.0267	0.0077	0.0032	13.8	2.4	16.2	14.0	1.0	15.0	0.50	9.0
14, .	A . .	0.0083	0.0219	0.0083	0.0171	13.3	3.3	16.6	11.4	3.0	14.4	0.47	7.9

It may be seen that the waters are all hard. The effect of the paper-mills in South Adams is shown in the great increase of solid matter from 13.6 at D to 23.1 at B, decreasing still to b, where it is 17.3, and not changing much thence to the State line. A considerable portion of this increase is due to matter in suspension. But from D to d, there is no striking increase in the organic matter. At B, however, a great increase is noticed in the organic matter and chlorine from some of the sewage of North Adams, and, to some extent, from the woollen and cotton mills on the north branch of the river.

From B to b there is a great decrease in both organic and inorganic matter, although there are several mills adding to the pollution between those points; showing that, especially with such a rapid fall in the stream, the processes of purification go on quite rapidly.

From b to the State line, the river flows quietly for about three miles without any fresh sources of contamination, except the very moderate surface drainage. It is joined by the smaller unpolluted streams shown on the map, and there is a slight but not very striking improvement in its condition.

At D, the river appeared pretty well, but slightly turbid; at d, clear but rather dark and peaty-looking; at B, rather turbid; at b, also quite turbid and dark; at a, still slightly turbid and dark, but not very bad, although with a considerable flocculent deposit on the bottom, and at A less turbid, but with a sticky deposit on the rocks.

At all of the six points examined, there was a slight amount of suspended matter, as is shown by the difference between the total residues of the filtered and unfiltered samples. This is to be expected to some extent in all river waters. At d and B, this difference is quite great, showing that the mills, as being the chief sources of pollution at these points, had added very considerably to the amount of suspended matter.

It cannot be said that there is, at present, danger of harmful pollution to the Hoosac River, except at North Adams; and the flow thence to the State line still diminishes the amount of contamination. The river does not pass near the village of Williamstown; and, if one of the evils is neces-

sary, it would be much better to have it even more polluted than now, rather than that the present nuisance from unre moved filth should continue to exist in North Adams.

Natural Drainage.

The limestone formation follows the bed of the southern branch of the Hoosac River, the lower portion of the northern branch, nearly the whole course of Green River, and the main stream of the Hoosac below North Adams, which village lies largely on the less porous metamorphic rocks of the paleozoic period, the limestone dipping under it. East and west, on the sides of the river bed and to the north, in Clarksburg, very like the Housatonic basin, the hills are of schist, granite, gneiss, quartz, and the harder lime-rocks.

The fall [1] of the river is rapid in South Adams, through a light, gravelly soil, slight for a couple of miles until reaching North Adams, where it is met by the Clarksburg hills, then turns an abrupt angle from north to west, where again it has a more rapid flow, and finally is more sluggish in its descent through the tough clay subsoil of Williamstown.

Diphtheria and Drainage.

South Adams, North Adams, and Williamstown, all lying in the valley, are thus quite differently situated in regard to natural drainage; and they again are unlike the shallow-soiled towns on the tops of the rocky hills, bleak, with moist subsoil, and often polluted wells. In some of these latter, both in this State and in Vermont, diphtheria has raged with a virulence resembling the plagues of the last century; in others, there have been fewer cases, and in still others, none. There are, to be sure, the insanitary conditions just pointed out in such towns; but, with our present knowledge, it is impossible to say why, under identical conditions, so far as we can see, — unless an unknown local miasm or specific germ be supposed, or the element of contagion be introduced, which also in some of the cases cannot be traced, — diphtheria prevailed in Clarksburg and Florida, and typhoid fever in Peru and Windsor. In all these places, dampness and filth co-exist in the soil to an extent liable to become dangerous to

[1] The exact fall in the various places may be followed on the map.

health; and these conditions are favorable to the propagation equally of diphtheria and typhoid fever, although under circumstances all of which are not known.

In Berkshire County, south of North Adams, diphtheria has occurred during its prevalence in the last few years; but, with the exception of brief and comparatively mild epidemics in Monterey and Lanesborough, not to an alarming extent, although in the northerly towns of the county, and especially in the Deerfield Valley to the east of them, that disease has appeared with terrible malignity, as it has also to the northward in Vermont.

In North Adams, South Adams, and in Williamstown, it has seemed desirable to compare the varying natural and artificial conditions, especially with reference to drainage, and to see whether there is any reason to account for the very great difference in the prevalence of diphtheria in those places; for all must have been pretty nearly equally exposed to the first contagion, as they lie near together, with constant intercommunication, and have all a certain proportion of their population among the ignorant and improvident classes, who work in some of the mills. Of course there are in all of these towns many American and very intelligent operatives; but a large proportion of them are foreigners, living under circumstances exceedingly unfavorable to health.

An attempt was made to collect data so as to examine somewhat particularly the surroundings of each house where deaths from diphtheria had occurred, especially in North Adams; but the registration of vital statistics was found to be too incomplete to make a minute examination possible, and there was not time for a house to house inquiry. Physicians, as a rule, are never called upon to give certificates of deaths in that town, unless for the removal of bodies to other towns; and the undertakers make their returns to the town clerk only once a year.

As late as November, it was found impossible to obtain reports of deaths which occurred after March 12; and the returns previous to that time so failed to correspond with the physicians' notes of their own cases, that they were not sufficient for our purpose. A different method, therefore, was pursued, consisting in a general inspection of the sanitary condition of the town, in which valuable assistance was re-

ceived from the physicians in practice there; without this, the examination would have been impossible.

We do not desire to throw any especial blame upon the officers of Adams. For the faults shown there are the result of years of inattention to the spirit of the law, exist to a considerable degree throughout the State, are partly, indeed, the result of inadequate laws, and illustrate the comparative valuelessness of a considerable portion of our vital statistics; although, with proper supervision, it would be nearly as easy, and no more costly, to have the work well done.

Williamstown.

The village of Williamstown is situated on high land, gradually sloping down to the Hoosac River and its tributary, Green River; but only a small part of the population live on the low land, if we except the occupants of the mill-tenements. It has not far from 3,000 inhabitants, very largely of the intelligent class, and an exceptionally good board of health. It has been noted for some years as a health resort during the summer months, and is the seat of the well-known college.

Its soil is a thin layer of gravel and sand, with a tough clay subsoil, cold and damp, overlying limestone; and some of the cellars would be wet if not drained. It is well exposed to the sun, and protected from severe winds. The air seems mild and pleasant.

Since the introduction of pure water, fevers have very much diminished in prevalence and are of a milder type. A few cases and groups of cases of diphtheria have occurred, in Williamstown, during its prevalence in this State for the last four years, most of which have been traced directly to contagion or infection; and it prevailed in 1860 to a certain extent there as elsewhere. But lately, nothing like an epidemic has occurred until October, 1876, when it appeared in a severe form by direct contagion from Pownall, Vt., among the operatives of the Williamstown Manufacturing Company, occupying tenements near the river, and rather separated from the rest of the town. Thence it was conveyed, by contagion clearly, to the hotel, where two children died. From the same place, too, its spread was traced to other parts of the town in the following manner:

A man attended the public funeral of a child who died of malignant diphtheria in the factory village, and returned to his house, A, on the hillside, whereupon his two children were taken ill with the disease, and died; of the three remaining in the house (all adults), the grandfather went down to a valley some distance off, to live with relatives having many children, and communicated the disease to them; and in three contiguous houses, having frequent inter-communication, until it was forbidden by the physicians, there were fifteen cases, of whom ten died. In a neighboring house, full of children, none were attacked with the disease. These four houses constituted that entire community.

When the children in house A died, a mother of a family from a house, B, on the opposite side of the ravine, went over to "lay the bodies out," and contracted the disease in so virulent a form that she died within twenty-four hours after calling a physician. Although there were four other children in the house, none of them were attacked with the disease.

In all, up to the end of May, there were eighty cases, all of which are thought to have occurred through contagion or infection, and thirty deaths, by Dr. Duncan's estimates. These occurred without reference to dryness or exposure of locality, filthy surroundings, clay or gravelly soil, &c.; but the fatality was greatest where the crowding was great, or conditions of dampness and filth prevailed, and the deaths were only among the less prosperous classes; i.e., if we except the two cases at the hotel. The Irish escaped almost entirely, and the disease prevailed chiefly among natives.

If we examine the sanitary surroundings of the places where diphtheria first appeared, we find that the tenement-houses of the mills, although not faultless as regards the disposal of slop-water, and not possessing a water-supply which is above suspicion, are probably in their general sanitary arrangements among the best in the county; and it is not likely that there are, on the whole, much better in the State.

But personal hygiene, ventilation, &c., so important as preventives of contagious diseases, are neglected, and the operatives are rather closely housed, although not so really overcrowded, as is often the case among that class.

Houses A and B were situated about alike, with pure air,

on the hill slopes, and quite isolated. Their water-supplies were from pure springs, and their surface drainage was of the best. But the soil was shallow, overlying rock, in the hollows of which there are opportunities for the soakage from sink-spouts and privies to settle, stagnate, and alternately moisten and become dry. Still, it must be said that even in these respects the houses were no worse off than a great proportion of those where no illness occurred, although they were rather small and had insufficient sleeping room for the occupants.

The fact that the children in B were not attacked is only analagous to our experience in regard to small-pox, measles, scarlet-fever, and other contagious and infectious diseases. The consideration of individual susceptibility is an important one in such a connection, and it is well known that not all who are exposed contract contagious diseases.

The three houses in the ravine, where the fifteen cases and ten deaths occurred, were very small, and in one case four persons slept in a single chamber. The drainage was good, the soil not tough, the water-supply pure, there was no offence from unremoved filth, and the exposure was sunny and pleasant; but the line of the ground-water was high, as the soil was only a couple of feet above the level of the brook and at the bottom of the hills. The fourth house, in which no cases occurred, was situated so as to be exposed to precisely the same influences, except contagion or infection.

In this town we have a tough, damp subsoil, and the appearance, by contagion, of a number of exceptionally severe cases; and we must assume that the disease exhausted itself for the time; i.e., that it attacked all the susceptible people who were exposed, or else that there were causes for its being limited, and not becoming endemic.

There seem good reasons for holding the latter opinion; for (1) the diphtheria appeared first in comparatively isolated places on the outskirts of the town, where the principle of separation or quarantine could be well carried out; (2) the isolation principle in treatment was carried out thoroughly by the physicians after the first few cases; (3) the sanitary conditions of the places where the disease first appeared, although not faultless, were much better than is commonly seen under similar circumstances, and there was nothing

that would ordinarily be called bad in any of them, so that the limitation of the disease would naturally be easier; (4) among the people of the town, the intelligent classes decidedly predominate, and with them personal hygiene is well attended to; (5) *there is an exceptionally excellent board of health* in the town, and the frequent removal of filth from out-houses, &c., has prevented that wholesale contamination of soil so common throughout our State.

There have been a few sporadic cases since that time, but none fatal [November, 1877]. One occurred in a house where there was a fatal case in the winter; and some bit of rag or clothing may have easily retained the infective material for that length of time. The other cases, it has not been possible to trace — in fact we cannot always do so in even such marked scourges as small-pox; and yet no one would deny that its spread depends upon contagion or infection, and nothing else.

Perhaps the care to prevent the accumulation of filth in Williamstown, and the other facts just mentioned, may have been a chief element in preventing diphtheria from getting a permanent foothold there. Still, with their damp subsoil, the introduction of a public water-supply without providing for its discharge by sewers, after having been polluted by various uses, constitutes a condition which can be considered only as being far from satisfactory in a sanitary point of view; and there will be various filth diseases in the town probably for some time to come.

Three wells were examined in Williamstown, with reference to their pollution. They illustrate admirably the insidious nature of drainage contamination.

TABLE XI. — *Examination of Well Waters in Williamstown.*

[Results expressed in parts per 100,000.]

No.	DATE.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.			Chlorine.	Filtered.			
										Solid Residue.	
				Inorganic.	"Organic and Volatile."	Total at 212° F.		Ammonia.	"Albuminoid Ammonia."	Organic and Volatile.	Total at 212° F.
1	September 14, ...	0.0059	0.0152	52.5	10.6	63.1	10.21	0.0059	0.0149	9.5	63.0
2	September 14, ...	0.0051	0.0128	93.6	18.5	112.1	40.04	0.0051	0.0109	14.7	108.6
3	November 7, ...	0.0037	0.0096	114.3	8.7	123.0	35.05	–	–	–	–
4	October 29, ...	0.0016	0.0085	17.6	1.7	19.3	1.71	–	–	–	–

The ferrous sulphate test gave no indications of nitrates in the unconcentrated water in the case of No. 1, and only faint indications in the case of No. 4, but Nos. 2 and 3 contained a very large amount of nitrates

No. 1 was from a well near the top of a hill, about fifty feet from a privy, one hundred feet from the barnyard at a slightly lower level, and in a gravelly soil. The water was very slightly opaline in appearance, and had the least possible drainage taste; but neither of these peculiarities would have attracted general attention. There had been one fatal case of typhoid pneumonia in the house early in 1876, and, later in the season, five persons contracted fever, of whom two died. The well water was found to contain so much filth that it was condemned at once, upon the result of the chemical examination. Leaving out the first case, as being a doubtful one, the other five were probably attributable to the use of the contaminated water.

Nos. 2 and 3 were taken at different times from a well between, and at one end of, a double row of tenement-houses belonging to one of the mills. It was about 50 feet from two double privies, 80 feet from another, and about six rods from a shed for horses. Some years ago this well was thought, with the faulty drainage, to have been the cause of a large number of cases of fever. The owners, however, remedied most of these evils when they were pointed out to them; and the well was abandoned, the pump having been entirely removed. The privy vaults were abandoned, too, for a system of dry removal by drawers, as is common in Williamstown. The pump has latterly been in use for watering horses and for washing clothes. Occasionally, too, it has been used by the operatives for obtaining drinking water; but its use has been given up for the latter purpose, since the analysis of the water revealed its dangerous character.

There has been no illness directly traceable to this well during the past summer; if any has occurred, it has been of an obscure nature and difficultly traced; indeed, its water of late has been very rarely used for drinking. The present examination shows the well to have been excessively polluted; the interesting point being, that it was clear, and did not suggest by taste or smell any possibility of filth contamination.

No. 4 is from a well on the same grounds as 2 and 3, but higher up, and more remote from sources of pollution. It is a surface well, about 400 feet from the nearest privy, and lying in the same loose soil with No. 2. It shows some

evidence of "previous sewage-contamination," not enough, by the present analysis, to justify its being condemned. At the same time, it should be looked upon with suspicion, from the mere fact of its connection with sources of filth. Its comparative remoteness from any sources of pollution indicates that the whole table of the ground water is probably somewhat polluted in that immediate neighborhood, so that the pure supply from the town might be introduced with propriety. It is held by most sanitarians that even in such a case as this the water might become dangerous to health in time of an epidemic of typhoid fever, for instance; as it is thought that "germs" of the disease may pass through any soil which allows filth in any form to pass through it. At the same time, from this examination alone, the well, used as it is by several families, cannot be called a dangerous source of supply, as the filth is not very considerable, and is mostly converted into inorganic forms.

South Adams.

South Adams is a half-dozen miles higher up the Hoosac River than North Adams. The intervale is much broader there, the slopes of the hills more gradual, the rock lies deeper under the surface, and the subsoil drainage is much better. It is only one-half as large, too, and much less a centre of traffic and travel, thereby giving fewer faculties for transmission of contagious diseases. The great difference, however, lies in the fact that the filth from privies is oftener removed and that the soil, better adapted, too, for natural self-purification, is not allowed to become so polluted, although it is far from clean. It is also dryer, and the underlying limestone is of a more porous character than in North Adams, which lies partly on the harder metamorphic rocks.

Whether because of the less soil moisture and filth, or for some other reason, only a few cases of diphtheria have appeared in South Adams, chiefly among the French Canadians; and of these only three were fatal. The disease soon disappeared, and in October there were a number of cases of fever in the tenements of one of the mills.

Where the diphtheria prevailed, and in the neighborhood of the typhoid fever, the tenements occupied by the sufferers

were wretchedly filthy, and sadly needing the offices of a board of health, although the water-supplies were pure.

If we were asked why diphtheria appeared in one tenement in August and September, and typhoid fever in the other in October, we should be obliged to say that we do not know, except that we think there is good reason for believing that each disease is produced by a specific poison, whether arising only from a parent case or *de novo* under certain conditions not yet known to us. But whatever theory we adopt, of specific poison, germ origin, miasmatic influence, or purely filth causation — and they all have their supporters — we must say that conditions favoring disease exist in both tenements, and that our experience warrants us in stating that destructive diseases will occasionally appear in both, until their causes shall be removed. The upholders of all the theories meet on this common ground, that filth and moisture constitute an important link in the causation of disease — a link more easily broken, too, from the fact that it is known and accessible.

The limestone rock in South Adams is softer than in North Adams, and is used for preparation of lime by burning; it has been suggested that these fumes acted as a disinfectant, and so were of favorable influence. But, a number of years ago, when diphtheria prevailed, it appeared chiefly in the immediate vicinity of the kilns, and where the fumes were most abundant.

As in North Adams and Williamstown, fevers have diminished in prevalence and severity since the introduction of pure water.

North Adams.

In North Adams diphtheria may almost be said to have become endemic. Since its appearance in 1874, it has prevailed quite constantly; and an enumeration of the deaths would be a sad list to many families. The registration has been so deficient that it is impossible now to ascertain the exact numbers of those who have fallen victims to this terrible scourge. From Jan. 1, 1876, to March 12, 1877 [later than which time, the returns are not accessible], the approximate number of deaths is 68, or at an annual rate of about 5 per 1,000 living.

The valley of the south branch of the Hoosac River lying north and south, with better exposure to the sun and broader intervale in the settled parts at least, has been quite free from diphtheria. In the valleys of the northern branch and of the united stream, lying at first nearly east and west, with houses more on the rocky hillsides, diphtheria has been prevalent. In the small towns of Readsboro', Vt., and Clarksburg, on the north branch, it has been especially so, but for short times.

In North Adams, the intervale narrows so that the village lies partly on the slopes of the hills on both sides; and quite a rocky eminence on its northern edge gives to the river a rapid turn in its flow from northward to westward. This, of course, causes an excellent, rapid surface drainage to the upper parts of the village, but the lower parts are sometimes flooded with water faster than it can flow off.

The subsoil drainage, however, is not in all places good, as the soil, although largely gravel, is shallow in many spots, and overlying a hard rock with uneven surfaces. Water in such a soil might, in time, find its way out between the crevices in the rocks, or by actual soakage through them; but filth is intercepted and must remain stored up in the hollows and pockets of the rocky surface; it even by its presence closes, to a certain extent, the pores in the rocks, thereby obstructing the passage for water or subsoil drainage.

This is precisely the condition in which wholesale pollution of the soil becomes inevitable, if filth is allowed to accumulate. In North Adams, it was first manifested in the great prevalence of typhoid fever, from polluted drinking-water, — now happily much reduced by the introduction of pure supplies from the mountains.

At the present time, the introduction of pure water has brought with it some water-closets and bath-rooms, a few drains and sewers, and a certain number of cesspools; and in these cases the rule has not been that proper measures have been taken to prevent the introduction of sewage gases into the houses. A very large number of privies, too, are in existence, many of them in quite a filthy condition, — the very first about which inquiry was made had not been emptied for twenty-nine years. The privy smell is marked in passing through some of the better streets, and in one case it was quite offensive where there was no privy within two hundred

feet. Many of the tenements of the mills, although no worse in principle than some of the houses of the better class, have, from the accumulation and concentration of the evil, become serious annoyances and dangerous to health.

The soil of North Adams, therefore, is suffering from two conditions unfavorable to health: (1) moisture of the deep soil from lack of subsoil drainage — but this only in places, and, perhaps, of itself alone, a less serious evil than might be supposed, owing to the excellent surface drainage; (2) general and almost universal contamination of the soil through storing up for years the filth from privies, sink-spouts, &c., in the hollows of the rocks underlying the soil.[1] Of course, a considerable portion of this filth finds its way into subterranean streams, but a large part can only lie for long periods of time where it must be constantly sending forth dangerous exhalations into the air.

In the lower parts of the village, where there is greatest moisture, where the cellars are often wet, and where the streets are sometimes covered with water, diphtheria has not prevailed more than on the hills, and, in the practice of some of the physicians, not so much.

It certainly cannot be said that diphtheria has prevailed in North Adams, or generally in Berkshire County, entirely in proportion to the filth, or in proportion to the soil moisture, or in proportion to the two combined. But there are many good reasons for thinking that the disease, like typhoid fever, is propagated more readily under a certain relative combination of the two conditions, the chief elements in which are almost if not quite unknown.

Of course, contagion, infection, and individual susceptibility to the disease, must be kept in mind, as important factors in the causation of the disease; and, in this connection, the remarkable immunity from contagious diseases among the Chinese workmen in the factory is especially noteworthy. Their isolated and regular[2] life seems to protect them.

[1] Compare the report on Gloucester, at a later page, where the conditions of bad drainage are similar, and where also diphtheria has prevailed for several years.

[2] Mr. Sing, who has charge of these men, states that drunkenness is almost an unknown occurrence among them; also that there is no opium-smoking and no licentiousness. We are informed, too, that a single Chinaman has never yet been brought before the police-court in that town.

However all these facts may be, of which there can be no doubt, in our own minds, it is certain that Adams is sadly in need of better sanitary arrangements and an efficient board of health ; and this is especially marked by the contrast in going thence to Pittsfield and Williamstown, whose admirable boards have very much improved the sanitary condition of those towns. It is not a comfortable reflection that a laige part of the illness in North Adams may be fairly traced to neglect of the plainest sanitary laws ; but the people of that town are intelligent, and it can hardly be doubted that they would soon welcome the help which they might receive from an efficient board of health, in overcoming many of the sources of disease.

In the tenement-houses of mills, frequent and persistent inspection, with careful and considerate pointing out of the evils of the present system, has had most excellent results elsewhere, and would probably also in Adams have the same. A little more cleanliness, a few bath-rooms for the operatives, and better house arrangements generally, would soon return to the owners in increased self-respect and more efficient labor.

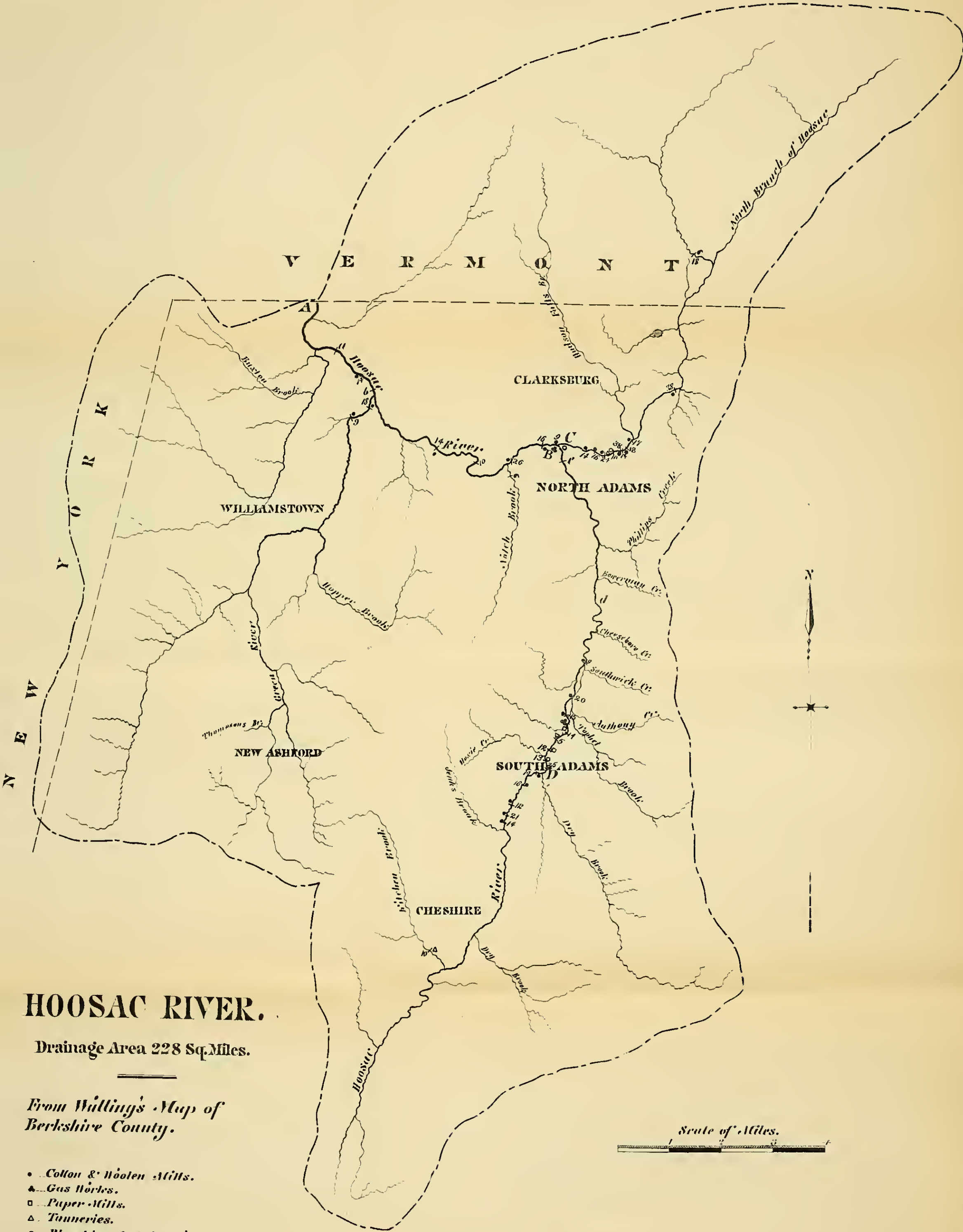
For voluntary work of the kind undertaken by the women in many English and American cities and towns, there is, of course, abundant room. A small hospital for those who have not homes is much needed.

In regard to the purely medical treatment of the diseases associated with bad drainage, that is the province of the physician, who is in daily contact with illness and to whom the latest sources of information are open : we would only say, that they are severe constitutional disorders, and that there is no known specific for any of them.

Chemical Examinations in North Adams.

In illustration of the general contamination of the soil, the following examinations have been made, under the direction of the Board, by Professor Nichols : —

freely with the river. The latter is decidedly unfit for an ice-



HOOSAC RIVER.

Drainage Area 228 Sq. Miles.

From Walling's Map of Berkshire County.

- Cotton & Woolen Mills.
- Gas Works.
- Paper Mills.
- Tanneries.
- Bleaching & Print Works.
- Acid Works.

TABLE XII. — *Examination of Water from North Adams.*

[Results expressed in parts per 100,000.]

Date.	No.	Unfiltered Water.		Solid Residue.			Chlorine.
		Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° F.	
Oct. 30,	No. 1,	0.0059	0.0160	12.2	1.7	13.9	0.67*
30,	2,	0.0112	0.0187	13.5	1.7	15.2	0.54*
30,	3,	0.0043	0.0060	45.3	6.5	51.8	4.55†
30,	4,	0.0043	0.0044	45.9	6.0	51.9	4.20†
30,	5,	0.0138	0.0088	28.2	3.5	31.7	2.22‡
30,	6,	0.0027	0.0048	16.5	2.0	18.5	1.19‡
Nov. 23,	7,	1.0083	0 0139	54.8	2.5	57.3	5.78†

* No indication of nitrates, by ferrous sulphate, in unconcentrated water.
† Very good indication of nitrates, by ferrous sulphate, in unconcentrated water.
‡ Very slight indication of nitrates, by ferrous sulphate, in unconcentrated water.

These results of chemical examination, although of themselves giving positive information as to the amount and not the character of the pollution, do, when interpreted with the aid of a careful survey of the localities in question, furnish most unequivocal facts, which may be stated as follows: —

Nos. 1 and 2 are from an arm of the Hoosac River, made into an artificial pond, shallow, in the midst of marsh land, and receiving the direct drainage, more or less, from the main road to South Adams and Cheshire, from numerous tenements, and from a large, filthy barnyard between 300 and 400 feet distant. Both specimens were turbid, from a small amount of suspended matter. No. 1 is from that portion separated from the river by a slight dam. No. 2 is from a point just back of the ice-house and communicating freely with the river. The latter is decidedly unfit for an ice-

supply;[1] and the former shows evidence of direct contamination, which, in deep water, especially if from a running stream, might not be proof positive that the locality should be condemned. The amount of "albuminoid ammonia" in both, shows them to be decidedly open to suspicion; i.e. for use in drinking-water — especially when we consider the locality.

It is impossible to say just what influence this ice may have had on the public health; but it is safe to state that it is open to serious objection and that a better supply should be looked for.

No. 3 is from the Quincy-street well, thought by many persons to be especially pure. It is in a moderately thickly-settled part of the town, close to the sidewalk, with privies, barns, sink-spouts, &c., in the immediate neighborhood. The nearest privy is about 100 feet distant. It is badly polluted, and should be condemned.

No. 4 is from the Crowley Spring, so called, at the foot of a gravelly slope. There are two privies about 100 feet distant and a little higher up. Within a thousand feet are several houses with their privies, &c., although the immediate neighborhood is sparsely settled. An interesting fact, as showing the intimate subterranean intercommunication, is that, while a hole was dug for a fountain several hundred feet distant from the spring, its waters were rendered so turbid as to be abandoned for the time, as a source of domestic water-supply. This water is very slightly different from that taken from the well (No. 3); indeed, as Professor Nichols says, it might be easily supposed to be a sample from the Quincy-street well, taken at a different time from the other. In both specimens (3 and 4), the water was clear; and none but experts would probably have been able to suspect, from the taste, the presence of any organic impurity.

No. 5 is from a well quite a distance up one of the hill-sides on Eagle Street, near a house where there has been considerable illness, such as is usually fairly attributable to the use of contaminated drinking-water. At certain times, in both winter and summer, when the water was low, there

[1] A full account of an epidemic of diarrhœal disease attributable to the use of impure ice, by Dr. A. H. Nichols, may be found in the Seventh Report.

has been a disagreeable taste, and occasionally also a nauseous smell to it, so that its use has been several times given up for the time being. The well is within 50 feet of a garden, on which the house slops are thrown during winter, only 100 feet from a privy which is emptied only once in two years, and which has no vault; also only a few hundred feet lower on the hill, too, from several houses with their privies, sink-spouts, &c. The water, at the time of examination, did not reveal, either by taste or smell, the slightest indication of impurity. It is unmistakably contaminated, however, by human filth; and, although this was chiefly oxidized and not in great quantity, when examined, yet it must be considered unsafe water to drink, even now, without boiling it.

The next in the series, No. 6, was from an apparently clear, sparkling spring, which bubbles out from the rocks, several hundred feet from any source of contamination, but at the base of the hill and across the street from the locality described in speaking of No. 5. So far as the unaided senses could perceive, this water was perfectly pure and wholesome. It contains, however, a certain amount of evidence of having been contaminated. The filth is in this case so far oxidized and converted into apparently harmless ingredients that it would not perhaps be wise or necessary to absolutely condemn it. At the same time, it contains an appreciable quantity of excrement, and gives evidence thereby of being in direct communication with sources from which a greater or more dangerous element might be introduced at any moment; i.e., if the wholesale pollution of the soil is allowed to go on indefinitely in this way.

No. 7 is from a spring 50 feet from a privy, almost as near the sink-spout, and across the street from a barnyard and barn. It certainly should be condemned. Three families used this water, and among them six died of diphtheria in the week ending Nov. 24. The water was suspected, although the immediate cause of the disease was due to contagion from a person who came from White Oaks, in Williamstown, just recovering from a mild attack of diphtheria, and who visited one of these families. The cases were very malignant; two died within 36 hours, and the other four within five days after being attacked. Two of the boys were removed before the attack to a house one-half mile distant,

and a young lady, seventeen years old, took the disease and died within two or three days. There are a few more mild cases in the same neighborhood, but only among those who have been exposed to one of these cases. Diphtheria of a malignant type was prevailing at White Oaks, although the person who apparently conveyed the disease to North Adams had it very mildly. The idea of Dr. Lawrence, the physician in charge, was that these cases were, or might have been, made worse by drinking polluted water.

A better series of samples probably could not have been taken to show how universal this contamination of the soil with filth has become in North Adams.[1] It is not necessary that it should be so, — in fact, it is repulsive to the natural sense of decency and cleanliness that such a state of things should be allowed to exist.

It has been clearly shown by these investigations that a dangerous amount of pollution may exist in drinking-water without its presence being revealed in any way to even the practised sense, unaided by chemical examination. The material which conveys disease, however, cannot be detected by the chemist, and is probably associated with, rather than is a necessary part of, the impurities which he finds.

In a similar way, the contaminated soil sends forth exhalations into the air, which are no less dangerous and much less easily recognized. In both cases, the chance of getting into the system any poison which conveys disease depends upon its dilution and upon various other contingencies, which, in the present state of science, are chiefly matters of speculation. But that there is a risk, and a great one, in breathing polluted air or in drinking polluted water is a fact now so well known that there is no maxim of sanitary law which is better established.

If the cause of some part of the illness in North Adams must be said to be largely due to the neglect of sanitary laws or the part of its inhabitants, so does the remedy, to a great extent, lie in the same hands. But while remedial and preventive measures are still unapplied, and there is not even a board of health in the town, it is vain for the people to

[1] Compare Brockton, Gloucester, Saugus, and Taunton, under Health of Towns in the present Report, for additional facts with regard to pollution of the soil, and consequently of wells also.

delude themselves by talking of the "mysterious disease" which has visited them.

The most economical method of remedying the soil pollution may not lie in the immediate introduction of sewerage; but that is certainly the best way; and a considerable increase in the pollution of the Hoosac River, if that is necessary, would be a much less evil than those now existing, of unremoved filth. Good sewerage, too, would very much improve the defective subsoil drainage of the town.

Legislative Measures.

So far as this investigation in the Housatonic and Hoosac basins is concerned, there is no evidence of sufficient pollution of any stream as to urgently demand legislative interference. It is important, however, that the larger towns, in introducing sewerage systems, should do so in such a manner as not to be prejudicial to the public health.

The condition in other towns and cities has been detailed in the seventh and eighth reports of the Board. There are not many, although there are some, where it is necessary that something should be done at once, but the cases are common throughout the State where it is important that existing evils should not be increased.

Previous to this year no evidence has been received from the manufacturers with regard to this point, in which they naturally would be interested. Circulars were therefore addressed to 363 of them in the State, embracing, as nearly as possible, all who were likely to cause or be annoyed by the pollution of streams in the eight basins already examined by the Board (Blackstone, Charles, Chicopee, Neponset, Taunton, Nashua, Hoosac, and Housatonic), and in the principal cities throughout the State, asking replies to questions as follows.

The same circulars were also sent to some manufacturers not on streams, whose opinions, it was thought, might be of use; and with each circular was sent so much of the eighth report of the Board as relates to the pollution of streams.

State Board of Health, Boston, August, 1877.

Dear Sir, — The State Board of Health have been for three years investigating the subject of pollution of streams, disposal of

sewage, &c., and are now required, by chap. 56 of the Resolves of 1877, to report to the next Legislature a draft of a bill on this subject. We desire to get information from as many manufacturers as possible in the State, and hope that you will reply, at your earliest possible convenience, to the following questions: —

1. Name, address, and kind of manufacturing done by you.

2. Are you at all troubled — and, if so, in what way — by contamination of the stream above your mills?

3. What kind of mills, in your opinion, most pollute the streams?

4. Do you think that any means — and, if so, what (settling-tanks, basins, filters, sewage irrigation, &c.) — are practicable for preventing this pollution?

In behalf of the State Board of Health,
Very respectfully yours,

CHAS. F. FOLSOM, M.D., *Secretary.*

Replies from Manufacturers.

One hundred and twenty-five answers were received. Of the remaining two hundred and thirty-eight who did not reply, it is probably safe to suppose that they are not enough troubled to enter any complaint.

Six of the returned circulars contained no answers of use, further than that the proprietors had given up business, or something of the sort. Of the remaining one hundred and nineteen, there were complaints of trouble in fourteen cases; and their replies to the second, third, and fourth questions are as follows: —

1. *Canton.* — We are more or less troubled from corrosion of steam-boilers, caused by chemicals used by parties on the stream above us, principally to dye silk and woollen goods. The water in the stream is too filthy to drink, except early in the spring, and then unfit.

Cotton and woollen mills are most polluting usually, from the use of chemicals, washings, and from the excrements from the operatives.

The practicable remedies are settling-tanks, filters, and irrigation.

2. *Clinton.* — *We are troubled very much indeed* with our pond. It is used for sewage by the entire town, and also as a deposit for all the refuse stuff they have to throw away. In fact, the stench is *horrible*, so much so that it is almost impossible to stay in our mill some of the time.

Woollen-mills are most polluting.

The only way to prevent this nuisance will be for the town to purchase the water-power, and fill the pond up, and put a sewer through it. We are willing to sell the power for what it is worth, leaving the question of amount to competent men.

3. *Dalton.* — The stream is very much colored with the dyes and washings of wool, rags, &c.

Woollen-mills most pollute the streams. I think, in this town, irrigation would be a practicable way to prevent pollution, as the soil is sandy.

4. *Fitchburg.* — We are troubled by foul water, partly caused by woollen and paper mills, of which the former are the most objectionable; but our principal trouble comes from the sewage of Fitchburg.

(Third question not answered.)

We think that, in most cases, settling-tanks or basins, made in gravelly soil, will best purify water which has been used in manufacturing. We think it would purify wash-water from a paper-mill. I have never seen any thing of the kind in this country, but have in England and Scotland. (The writer of this is a paper manufacturer.)

5. *Fitchburg.* — The river-water above my mill is too polluted to use, particularly in low stages of water.

I should say paper-mills are the most polluting.

I have no doubt we shall eventually have to make use of a main sewer, to extend from West Fitchburg to a point below the city of Fitchburg, where the accumulation of sewage could be made of profitable use for agricultural purposes.

6. *Holyoke.* — By refuse from woollen-mills, the water is highly discolored, and filled with small fibres of wool refuse.

Woollen-mills are most polluting. I do not know the best means of preventing the pollution; never studied the question very much.

7. *Leominster.* — We are so troubled by sewage, as to be obliged to use town water for steam and all other purposes in the shop. The stream is also used as a depository for dead cats, dogs, poultry, putrid meat, garbage, and every thing else the people have occasion to rid themselves of.

Woollen-mills, when large quantities of copperas are used, seem to kill the fish, thereby causing much nastiness.

I think sewage should be carried below the probable limits of the village; and stringent laws should be passed against depositing garbage and other matter in the stream, as also a law requiring owners of mill-ponds to get permission from the local board of health before being able to draw off the water. The pond on which I am situated is, in most seasons, drawn off half the time, causing bad smells, and rendering what water is left very foul.

8. *Needham.* — We are troubled by acids from paper-mills emptying into the pond.

Wool-fulling, so far as our experience here goes, is most polluting.

(Fourth question not answered.)

9. *North Adams.* — We have no serious trouble. At times we experience some trouble from the print-works above us, in consequence of their letting dyes and acids into the stream.

Print-works are most polluting.

If all mills using water from the streams should filter them before returning them to the streams, it would obviate any difficulty.

10. *Readville.* — We are troubled by two woollen-mills about a mile above us, which, as I understand, empty their dyestuffs and other filth into the stream.

I cannot say what mills most pollute the streams. I am not sufficiently acquainted with the details of the various manufactures of the State to give any definite information. Woollen-mills pollute the streams more than cotton-mills.

I can think of but one way to prevent this pollution of streams. Let it be enacted that no stream shall be used as a common sewer. Whether this would be practicable or not, I cannot say.

11. *Shirley.* — We are troubled by two leather-board mills.

Leather-board mills and dyeing-mills are most polluting.

Filters, if carried to a sufficient extent, constitute the best practicable remedy.

12. *Walpole.* — I think the pollution of streams might be prevented by pumping the water up in tanks, cleansing it, and saving the filth, to be used on the soil as manure, instead of polluting the streams.

13. *Walpole.* — Until within a short time, a manufactory of curled hair poisoned our stream (the Neponset River) very badly, proving fatal to quite a number of operations. I think little or nothing is being done there now. Our waters are very badly polluted by a concern in Walpole Centre, which uses chemicals for bleaching oily waste. The result has been to render the water unfit for

drinking and too nasty for bathing, and to destroy almost entirely all the fish with which our waters once swarmed.

Those mills most pollute the streams which empty into them the largest amount of filthy or poisonous matter.

I know of no remedy except keeping the vile stuff out of the streams.

14. ———. The washings of wool always troubled us, but perhaps no more than was necessary. Our pump, located six feet under water, would throw up a half peck of wool during one day.

There were qualified complaints in 13 cases, as follows: —

1. *Dalton.* — No trouble, because I abandoned the use of river water, and get wells and springs enough at great expense.

Woollen-mills are most polluting.

The best practicable remedies are basins. The silt caught would pay for all trouble, — for use on land or putting into compost heaps, — say clear out and carry away the settlings once a year.

2. *Fall River.* — We are troubled in no way except by ashes being dumped in, which is now being remedied.

3. *Foxborough.* — I am not troubled except when wishing to use the water for drinking.

Chemicals and acids, especially from dye-houses, &c., are most polluting.

I have been in mills more or less all my life; and I can see no way to prevent this pollution in the streams but a good live agent, or an inspector of mills and streams, with the law to see to it.

4. *Holyoke.* — Very little trouble by the dyestuffs, &c., from woollen and cotton factories, &c., located on the canal above our mills.

The most polluting mills are all kinds *except* paper-mills. (Reply comes from a paper-mill.)

The best practicable remedies are settling-tanks and filters.

5. *Housatonic.* — We have no complaints to make.

The most polluting mills are, in this vicinity, in my opinion, mills like ours (fancy colored cottons) and paper-mills, — and I might include woollen-mills.

I cannot write from experience in regard to prevention of pollution; but, if permitted to express an opinion, should say that the present practice of running spent dyestuffs, acids, lime, &c. directly into the streams, would conduce to the health of the

people better than any other means by which it could be disposed of.

6. *Hyde Park.* — We have been more or less troubled, but are not at the present time.

Woollen-mills are most polluting.

I am not prepared to give any opinion as to remedies.

7. *Lawrence.* — Not troubled to an appreciable extent.

The most polluting mills are, in our experience, dye-houses and bleacheries first, and paper-mills second. (Reply comes from a paper-mill.)

There are no practicable remedies, in our opinion, in a stream of this size; i.e. the Merrimack River.

8. *Lee.* — In no way to injure water for use.

Woollen and cotton mills are most polluting.

In no way can pollution be prevented so well, and conduce so much to the health of the inhabitants of the towns contiguous to manufacturing districts, as to let all waste of mills pass into and be carried away in *live* running water. Any receptacles for the waste of mills, where it is stored to stagnate, fester, and decay, are far more dangerous to the health of the inhabitants living in the vicinity of them, than when it is carried off by the rising stream and showers; and the health of the people is proverbially better where this is done.

9. *Pittsfield.* — I have to filter the water before using for washing purposes. The water, when settled, shows a sediment of fine black mud.

Woollen-mills are most polluting, or any other than a paper-mill. (Reply is from a paper-mill.)

The pollution of streams may be prevented in a great measure by making basins to hold dry refuse from mills; and liquids run on to the refuse would make fertilizers.

10. *Stoughton.* — I do not know that we have any fault to find at present. There is a woollen-mill above us.

As to questions 3 and 4, I do not know.

11. *Walpole.* — We draw our water-supply for the works from a spring of our own.

The drain that conducts the spent liquors, &c., from our works to the Neponset River is cleaned out from time to time. Nearly all the sediment settles out before it gets to the river, and what goes into the river has not, in over thirty years, appeared to have done any injury; a curious fact is that fish are caught in larger numbers about that point of the river where the drain enters than elsewhere.

As a practicable remedy, I think very favorably of settling-

tanks and precipitating-basins. Our twenty-rod drain, mentioned above, is what might be called a settling-tank.

12. *Walpole.* — We are not particularly troubled, although the water is not very pure.

Those mills are most polluting which use soluble salts in manufacturing; also those that deal with animal substances.

I think the streams' pollution can be prevented to a certain extent, and perhaps entirely, by one or another of the expedients suggested (settling-tanks, basins, filters, sewage-irrigation &c.).

13. ———. The difficulty here is chiefly as to quantity of water.

In seven cases the water was polluted from other sources than the mills, thus —

1. *Fitchburg.* — We are not troubled except when the water is very low, and is drained from the old swamp; then the color is too dark a yellow to use in washing stock.

Saw-mills fill up the beds of the streams most.

As a means of preventing pollution, I know of nothing better than the showers we have to cleanse our streams.

2. *Fitchburg.* — We are troubled by the decay of vegetable matter in the swamps and meadows at heads of streams, and by the impurities which find their way to the stream from highways and mills.

There is not much difference between a woollen and paper mill, as to pollution; they are probably as bad as any thing, since saw-mills are given up.

I do not think it practicable to prevent the pollution, except at such expense as would compel all manufacturing interests to seek some other State in which to do their business.

3. *Holyoke.* — We are sometimes troubled by bad water in the Connecticut River above Holyoke; but we have laid it to decaying vegetation.

The wood-pulp mill near us troubles us a good deal at times; we are not familiar with the refuse of other mills, and therefore cannot judge of them.

We cannot see how the refuse from the mills can be turned anywhere excepting into the streams, and we do not believe any means practicable for preventing this pollution.

4. *Lawrence.* — We are troubled with sand, in spring and fall, during heavy rains. We find no trouble with the refuse that comes from the mills at Lowell, nine miles above us.

Mills that make woollen goods and dress goods are the most polluting.

I am told they have these things (filters, settling-tanks &c.) in England, and that they work well.

5. *Lawrence.* — The Merrimac River is influenced fifty or sixty days yearly, with freshets, mostly in the spring months. The water is loaded more or less with earthy impurities. The maximum solid matter we have found to be fully half an ounce per gallon. So annoying is the impure state of the river during freshets, that bleacheries, &c., are compelled to obtain pure water by filtration or from other sources.

Paper-mills, woollen-mills, and dyeing establishments have the reputation of being great polluters of rivers.

The last is too great a question to express an intelligent opinion upon, without special examination.

6. *Lowell.* — The water used by us comes from the Concord River. We are very seldom troubled with impurities. Sometimes, during a prolonged state of low water, *in the summer time*, we cannot use the water for dyeing light shades, because of vegetable growth in it, somewhat similar to that upon a stagnant pool.

As between cotton and woollen and worsted mills, we think the cotton are the worst. We do not know any thing about impurities from industries other than the above.

I should hardly think any prevention of pollution necessary in the Concord River, between Billerica and Lowell.

7. *Stoughton.* — I am not troubled, except after heavy rains, when the mud and vegetable matter from the meadows above make the water so dirty that I cannot use it on light colors or white.

As to questions 3 and 4, I am not sufficiently acquainted to judge.

Of the remaining 85 cases, i.e., in which an unequivocal "No" was sent in reply to the second question, in 22 there were no answers to the third and fourth questions;[1] in 23 those questions were answered, but to the effect that the writers were unable to give any opinion, usually from lack of sufficient knowledge of or attention to the subject. The replies in the remaining 40 cases are as follows: —

[1] These questions were: (3) What kind of mills, in your opinion, most pollute the streams?

(4) Do you think that any means — and, if so, what (settling-tanks, basins, filters, sewage irrigation, &c.) — are practicable for preventing this pollution?

1. *Barre.* — (3) Paper-mills.

2. *Canton.* — (3) Bleacheries. (4) Do not know.

3. *Canton.* — (3) Those from which large quantities of refuse dyes and scouring liquids are sent directly into the stream. (4) Certainly; and we think that in many cases the refuse-liquids, from a wool-scouring mill especially, could be turned to advantage as a manure, for, by sending these refuse liquids into an artificial pond or basin, the greater part will filter through the earth; and the sediment that remains can be carted away once or twice a year, and used as a fertilizer. . It will pay for the outlay.

4. *Chicopee Falls.* — (3) Woollen-mills, with dye-houses.

(4.) In case of the Lancaster mills, there at present appears no cause for applying means for prevention of pollution. The town of Clinton has appointed a committee to examine and report in regard to the counterpane or quilt mill-pond, which is undoubtedly a nuisance, receiving the washings of the gas-company and the carpet-mill, and the sewage and drainage of more than half the town. The abatement of this nuisance will require a great expenditure of money.

5. ———. (3) Woollen-mills and coloring-works.

6. *Chicopee Falls.* — (3) Tanneries and such like.

7. *Clinton.* — (3) Chemical, woollen, dyeing, &c. We dye cotton yarn, say 40,000 pounds per week; yet fishermen catch small fish for bait below our works. Above our works we catch pickerel, pout, shiners, and eels three feet and a half long.

8. ———. (3) Fancy woollen. (4) Sewage-irrigation, when the soil is favorable; where not, filtration.

9. *Dalton.* — (3) Not any kind very much in our section; paper stock or waste from such mills might kill fish. (4) Nothing to say.

10. *East Dedham.* — (3) Our experience has been with woollen mills only; and, so far as I have observed, the pollution of streams by them is very slight; should say that water below our mills would not be fit to drink, unless taken out one or two miles below. The dye-house and wool-scouring would cause the most pollution. (4) I have never seen any of the above-named means tried, and hardly see how the prevention of pollution in these ways could be made practicable.

11. *Enfield.* — (3) Woollen or yarn mills, where dye-houses are, and colored work is made. (4) I consider settling-tanks or irrigation most efficient and practicable.

12. *Fall River.* — (3) Print-works and chemical factories. (4) A combination of settling-tanks, working in pairs, and sand filters, will obviate nearly any degree of pollution.

13. *Fitchburg.* — (3) With us, paper-mills and woollen-mills. But they are located so far up the stream, that no trouble is experienced in the central part of our city. The city sewers probably pollute the river more than any thing we have.

14. *Foxborough.* — (3) Manufacture of dyestuffs. (4) If allowed to run into a reservoir, the refuse will usually clean itself by settling.

15. *Holden.* — (3) Tanneries. (4) Should judge irrigation to be the best, for it would enrich the land.

16. *Holyoke.* — (3) Dye-works.

17. *Hyde Park.* — (3) Woollen-mills. (4) There is no remedy, unless the mill-owners are required to keep all the sources of pollution out of the streams, which would damage the mill-owners, more than the foreign matters injure the stream.

18. *Lawrence.* — (3) Dye-houses, bleacheries, and water-closets, that discharge into the stream. (4) Not in large streams like the Merrimac River.

19. *Leominster.* — (3) We should judge those where coloring is done. (4) We should judge that filters are best, but are very little acquainted, and do not know that there is any remedy.

20. *Lowell.* — (3) Bleaching and dyeing. (4) Not any need here.

21. *Lowell.* — (3) Such mills as use coloring materials, with salts and acids. (4) I know of no way practicable for the prevention of the evil, so far as it may be caused by extensive manufactories. Objectionable materials pass from mills in such quantities, and so diluted, that settling-tanks or basins would be of little account. While there may be a show of coloring matter from wood, &c., the percentage of really injurious materials would be very small.

22. *Lowell.* — (3) As an opinion, should say woollen-mills and tanneries.

23. *North Adams.* — (3) Woollen. (4) Settling-tanks, basins, filters, sewage-irrigation, &c., for the most of the refuse.

24. *North Adams.* — (3) Print-works and woollen-mills; also paper mills. (4) Never having tried any thing of the kind, we are unable to give an opinion.

25. *Norwood.*— Our own tannery, although there is some impurity from the paper-mills above, not enough to cause complaint. (4) We are careful (by the different means named in the circular) to prevent, as far as possible, pollution below us. We use now a good large basin and settling-tanks (removed from all houses), from which we cast off the refuse deposit for dressing the land.

26. *Norwood.* — (3) Tanneries, ink-works, paper-mills (where bleaching and coloring substances are used), dye-houses, and

chemical works of all kinds. (4) I think that settling-tanks or basins would be practicable in many cases, and irrigation in some.

27. *Pittsfield.* — (3) Do not know. (4) I should think settling-tanks or basins might be used ; but nothing of the kind is, in our opinion, needed in this section, as the mills (nearly all woollen) are located so far apart ; and the fall of the streams is sufficient to carry off all polluting matter.

28. *Pittsfield.* — (3) Printing cotton-cloth or print mills. (4) I think of no remedy that is effective, only to let the stream carry it away as rapidly as possible.

29. *Shirley.* — (3) Tanneries, woollen-mills, chemicals, &c. (4) I think there can be a means of prevention ; and it should be by utilizing through irrigation or similar device.

30. *South Adams.* — (3) Woollen and print works. (4) Settling-tanks.

31. *South Walpole.* — (3) Wool-scouring, if done on a large scale. (4) I have not experience enough, or given the subject sufficient thought, to advise ; but should think, in most cases, the water should run a separate course after being used, before again entering a stream or pond, in which settling-tanks and coarse filters should be placed. The expense would be small, and I should think the result would pay.

32. *Taunton.* — (3) Woollen-mills. (4) We have no plan.

33. *Three Rivers.* — (3) Colored woollen. (4) Not having been troubled, we are not prepared to give an opinion.

34. *Walpole.* — (3) Bleaching paper-stock, scouring wool, and cleansing oily waste. (4) Not competent to give an opinion, but something is necessary.

35. *Ware.* — (3) Colored woollen. (4) Have had no trouble, and have no opinion.

36. ———. (3) Tanneries. (4) Conduct the heavy sediment liquors into basins or cellars, for compost: from woollen-mills it is very valuable as a fertilizer. (Reply from a woollen-mill.)

37. *Ware.* — (3) Paper-mills. (4) Do not know.

38. *Warren.* — (3) Calico-printing, and any large establishment where large quantities of dye-wood and minerals are used for coloring. (4) We are not posted on this question.

39. *Wilbraham.* — (3) Chemical or compost works and *large* wool-washing mills. (4) I have never seen any of these means in operation, and think that, at present, the prime cost and yearly expense would come to a great deal more than the advantage accruing.

40. *Williamstown.* — (3) Print-works more than any other mills in our vicinity. (4) I have never given this much thought, not being troubled.

In regard to the last and most interesting question, as to the means of preventing or remedying the pollution of streams, the whole number of replies to the circulars have been tabulated, with the following results:

Forty-two (42) fail to answer that question at all.

Twenty-five (25) are unprepared to give any opinion.

Four (4) think that nothing is needed in their special localities.

Sixteen (16) think that, taking all things into consideration, nothing is better (and at the same time practicable) than allowing the filth to run off by the streams.

Thirty-eight (38) think that some remedy, complete or partial, is practicable; and of these, all but six suggest in a general way what that remedy should be.

Summary and Draft of a Law.

From the evidence presented in this and the previous reports of the Board, it is clear that there are some places in the State where harm is already done by the pollution of water-courses, although not to that extent which may commonly be seen in England, for instance; it appears, too, that there are many places where proper care may prevent the extension of lesser evils, which now appear to threaten to do harm in the future, unless checked, but that, as a whole, throughout the State, the evil from the pollution of streams is small as compared with that arising from the accumulation of filth in privies, cesspools, &c., &c., near dwellings, thereby contaminating the air and the water taken into the human system.

In order to encourage towns, moreover, to make the greatest possible sanitary improvements, no unnecessary expenditure of money must be thrown in their way, at the same time that harmful pollution of streams must be prevented; and it will, therefore, be necessary to regulate, rather than wholly prohibit, the contamination by filth of our waters.

It would be unwise, also, to place too great restrictions upon manufacturers by setting up, for all cases, some arbi-

trary standard of purity, which must be always followed, but which could not be enforced.

Any legislative enactment, therefore, should be stringent in many points, and yet somewhat flexible in its application. To this end, the Board prepared a draft of a law on this subject in May, 1877, and sent it to several distinguished lawyers, physicians, and engineers for their criticism. It was also made the subject of a paper read by the Secretary of the Board before the American Public Health Association in September, when it was criticised by the gentlemen present.

As a result of their three years' investigation, and in compliance with chapter 56 of the Resolves of 1877,[1] the Board respectfully advise that a Rivers Pollution Commission be established by law: the responsibilities of this commission to be placed in some board already existing, or in a new board; and they also have the honor to recommend to the Legislature the propositions which are given below.

The law, as proposed by the Board, covers more ground than is suggested by the legislative Resolve, but it was found that there were practical objections in the way of limiting the recommendations of the Board.

English Experience.

Under the English law, which went into operation last August, one year after its enactment, Mr. Robert Rawlinson, C.E., C.B., and Dr. R. Angus Smith have been appointed inspectors. The provisions of the law, which were given in full in the last report of the Board, are briefly as follows: —

I. Prohibition as to casting solid matters (ashes, dead animals, &c.) into water-courses.

II. Prohibition as to casting sewage proper into water-courses. In case, however, of sewage discharged by channels in use or in process of construction at the date of passage of the Act, it will be sufficient to show that the best practicable and available means are used to render harmless the sewage so discharged; and the Local Government Board may al-

[1] *Resolved*, That the State Board of Health be and they hereby are authorized to inquire what legislation is necessary to prevent the pollution of streams and ponds used as sources of water-supply by cities and towns in the Commonwealth, with authority to make examinations, call witnesses, and to report, by bill or otherwise, to the next general court. *Approved April* 27, 1877.

low to sanitary authorities time, in order to adopt such means.

III. (1.) Prohibition as to casting poisonous, noxious, or polluting refuse from manufactories into water-courses, with the same provisions as above with regard to channels already in use or in process of construction. Proceedings against manufacturers can be taken only by consent of the Local Government Board, who must be satisfied that means for rendering the manufacturing refuse harmless are reasonably practicable and available, under all the circumstances of the case, and that no material injury will be inflicted upon the interests of the manufacturers.

(2.) Restrictions as to solid matters from mines.

Beyond the fact of the enactment of this law, the interpretation and enforcement of which will undoubtedly depend very largely upon the well-known views of the officers of the Local Government Board, there is very little new to be said with regard to the experience of England during the last year in the matter of the disposal of sewage. Where deep-water outlets cannot be permitted, irrigation remains the most approved method, and, under favorable circumstances, the least costly; but the difficulty of getting sufficient land, and the enormous rents often asked for it, frequently render such means entirely out of the question. Indeed, one of the farms at Croydon has necessarily been abandoned for this reason, and a considerable sum has been paid for the privilege of discharging the sewage into a large, deep-water intercepting sewer. The intermittent downward filtration system, which was at one time thought to promise a remedy in such cases, by disposing of the sewage on very small plots of land, has not been entirely successful, and has not apparently grown in favor; for the amount of land necessary for it, at first thought to be about one-twentieth as much as for ordinary irrigation, proves by experience to be at least one-fifth as much; and at Merthyr Tydfil in Wales, during the past year, one-third of the quantity needed for ordinary irrigation has actually been used. The precipitating processes, therefore, have rather gained in favor, as some of their objectionable features have been removed, especially at Leeds and Coventry. In those two places, at least, where the effluent passes also through filter beds, no more satisfactory method appar-

ently can be devised[1] in spite of their being in some respects unsatisfactory and costly. Dry removal, too, under some conditions, gives the least unsatisfactory results. For most cases, the deep-water outlet is universally preferred, as involving, on the whole, the least difficulty.

These points, of course, cannot be dealt with in detail here, particularly as they have been considered fully in previous reports of the Board. The most valuable contributions to the literature of the subject, as applied to England, since our last report, are the minutes of the proceedings of the Institution of Civil Engineers on the Sewage Question,[2] and the report of the results of the Second Conference on Health and Sewage of Towns, held in London under the auspices of the Society of Arts, May 3 and 4, 1877. The Conference passed resolutions, the more important of which we quote with full approval: —

1. That the pail system, under proper regulations for early and frequent removal, is greatly superior to all privies, cesspools, ashpits, and middens, and possesses manifold advantages in regard to health and cleanliness, whilst its results in economy and facility of utilization, often compare favorably with those of water-carried sewage.

2. That hitherto no mode of utilizing the excreta has been brought into operation, which repays the cost of collection.

3. That the almost universal practice of mixing ashes with the pail products, though it applies these as a convenient absorbent, and possibly, to some extent, as a deodorant, is injurious to the value of the excreta as manure.

4. That, for use within the house, no system has been found in practice to take the place of the water-closet.

5. That, although there are appliances and arrangements by means of which the sewer-gases may be effectually prevented from entering houses, they still do so in the great majority of dwellings, both in town and country, including the metropolis.

6. That it is of the highest importance, in a sanitary point of view, that the metropolitan and local authorities shall exercise great vigilance with respect to this matter, and that it should be

[1] The precipitating processes are well described in *Purification of Water-carried Sewage*. By Henry Robinson, M. Inst. C.E., and John Charles Melliss, Assoc. Inst. C.E. Smith, Elder, and Co., London, 1877.

[2] Vol. XLVIII., Session 1876–77. Part II. London, 1877.

made by law the duty of these bodies to enforce efficient measures for the exclusion of sewer-gases from dwellings, and to watch over their being efficiently carried out, under such a system of payment as shall not press too heavily on those at whose charge the work is done.

7. That in every large town, plans of its drainage should be deposited with the local authorities, and be accessible to the public.

8. That all middens, privies, and cesspools in towns should be abolished by law, due regard in point of time being had to the condition of each locality.

France.

In France, the precipitating processes have not yet received any official support; and irrigation is the sanctioned method for disposing of the sewage, when some means of purification are needed. The sewage farming of Paris, now a city of nearly 2,000,000 inhabitants, is making reasonable progress, and it is hoped by the municipal authorities that eventually the whole of the sewage will be dealt with in that way, including the removal of all cesspools, and the abandonment of the colossal nuisance from carrying their contents to Bondy, and storing them there for treatment. During the year, the *Préfecture de la Seine* have published a very valuable account of general, and especially English, experience on this whole question.[1]

Germany.

In Germany, where land can generally be got at a fair rate, official opinion and experience in various parts of the empire, point to irrigation as the only practicable method. Precipitation is not used. The whole of the sewage of Berlin is to be used in irrigation, and, with that view, nearly 20,000 acres of land have been purchased, which is probably much more than will be actually needed. This work is rapidly going on towards completion.

In Frankfort-on-the-Main, the distinguished engineer, Mr. W. Lindley, is preparing plans for a sewage-farm; and in the case of several other cities (Cologne, Stettin, Posen) where

[1] *Assainissement de la Seine: Épuration et Utilization des Eaux d'Égouts.* Paris, 1877.

sewerage systems are under advisement, the government has actually forbidden the discharge of sewage into the river, taking the ground that, in those cases, all sewage is pollution and must, when practicable, be kept out of the streams.

Massachusetts.

The means of rendering harmless and inoffensive the sewage of towns and the refuse from manufactories are almost unknown in this country except from the experience of Europe, where they have been fully tried for the past twenty-five years. In a practical way, scarcely a beginning has been made here; and, such being the case, it would be impracticable to wholly stop at once the pollution of streams by means of methods untried by us. In the case of such cities as Lowell and Lawrence particularly, it would be extremely difficult to meet all the requirements of such absolute prohibition.

At the present time, cities and towns may regulate the use of ponds, reservoirs, &c., used for water-supplies, and also the driveways, parks, &c., connected with and belonging to them. There are also penalties for malicious or wilful pollution of water-supplies; but beyond these points the law at present does not go.

It should be borne in mind, therefore, that this is really the first step to be taken by the State, and that even more general restrictive measures may be applied a few years hence, if it be found necessary or expedient to do so, and when we have gained more experience in regard to the practicable methods of separating the filth from the water.

The application of the law to the two cities just named, for instance, is of considerable importance to both of them. On the one hand, under its provisions, the people of Lowell would be prohibited from adding to the pollution of the Merrimac River, and therefore could not introduce water-closets or additional sewers, unless they at the same time provided for the purification, by irrigation or otherwise, of the additional amount of sewage thereby to be discharged. On the other hand, Lowell is a large and growing city; it is important to the people of Lawrence, nine miles below, that the river, upon which they are dependent for a supply of pure water,

should not become more and more polluted from year to year, so as to finally be unfit for domestic use.

There are one or two apparent discrepancies in the law at first sight; but it may be seen that they are only apparently such, inasmuch as the questions relative to them are all referred to the Rivers Pollution Commission for approval.

A Bill to Prevent the Pollution of Streams, and for Other Purposes.

Definitions.

The word "stream" does not include water-courses which have been converted into tight, covered sewers.

The word "sewer" does not include local drains not emptying into ponds or streams.

The phrase "domestic water-supply" is used in the sense of water supplied to families for drinking or culinary purposes, and does not include private wells or springs.

The approval of the Rivers Pollution Commission, under this act, includes a general permission, without the requirement of their approval in each individual case.

The word "privy" implies the ordinary vault in or upon the earth, whether cemented or not. It does not include receptacles properly arranged for disinfection and frequent dry removal of the excrement.

Solid Matters.

Section 1. No individual or corporation, and no authorities of any city or town, or public institution, shall discharge, or cause to be discharged, or knowingly permit to be discharged, into any stream or public pond in this Commonwealth (including tidal waters), any solid refuse, including sawdust, ashes, cinders, and like substances, or any solid polluting substance, so as, either singly or in combination with other similar acts of the same party or of any other party, to interfere with its volume or flow, or pollute its waters: *provided*, that such interference with the volume or flow of any body of water be not for the purpose of making sanitary or other improvements. But this prohibition shall not apply to liquids containing not more than two per cent of solid matter in suspension.

Sect. 2. No stream or public pond (including tidal waters) shall be wholly or in part filled with solid matter for the purpose of making improvements, or for any other reason, and no stream shall be converted into a sewer in any city or town, without the written authority or permission of the mayor and aldermen or of the selectmen of said city or town, under general regulations furnished by the Rivers Pollution Commission.

Water-Supplies.

Sect. 3 No individual or corporation, or authorities of any city or town, or public institution, shall add, or cause to be added, or knowingly permit to be added, to the quantity of refuse polluting matter discharged into any pond in this Commonwealth used as a source of domestic water-supply, or into any stream so used within fifteen miles above the point where such supply is taken.

Sect. 4. No individual or corporation, or authorities of any city or town, or public institution, shall discharge, or cause to be discharged, or knowingly permit to be discharged, into any stream or pond in this Commonwealth used as a source of domestic water-supply, any sewage or refuse matter containing human excrement, or any soiled water which has been used in or about dwellings, over and above what is so discharged without violating existing laws at the time of the passage of this act: *provided*, such discharge in the case of running streams used as water-supplies, or emptying into streams or ponds used as water-supplies, be within thirty miles of and above the point at which such water-supply is taken.

Sect. 5. No individual or corporation, and no authorities of any city, town, or public institution, shall discharge, or cause to be discharged, or knowingly permit to be discharged, from any manufactory, house, or building of any kind established or built after the adoption of any pond or stream in this Commonwealth as a source of domestic water-supply, any refuse matter into said pond or stream until it shall have been cleansed or purified in a manner satisfactory to the Rivers Pollution Commission. This prohibition, so far as is not provided for in preceding sections, shall not apply to now-existing pollution of present sources of water-supply. But the Rivers Pollution Commission shall allow to local authorities a reasonable length of time to comply with the provisions of sections three, four and five of this act.

Streams, Ponds, and Tidal Waters.

Sect. 6. No individual or corporation, and no authorities of any city or town, or public institution, shall add, or cause to be added, or knowingly permit to be added, to the amount of refuse or polluting substance discharged into any stream, or public pond, or tidal water, not used as a source of domestic water-supply, in this Commonwealth, without the written permission of the board of health of the city or town in which said discharge is intended, and with the approval of the Rivers Pollution Commission; and it shall be in the power of said board of health, with the approval of the Rivers Pollution Commission, to prescribe under what conditions, where such are deemed by them necessary, any polluting substances may be allowed, in any given case, to enter a pond or stream.

Water-Supply, Drainage, and Sewerage.

Sect. 7. In cities and towns supplied with sewers, said cities and towns shall allow the sewage of manufactories to be discharged through the public sewers: *provided*, such sewage contain no poisonous chemi-

cals; no substance injurious to the structure of said sewers; no substances causing such obstructions in them as can be remedied only by means not necessary for ordinary sewage; no steam, gases, or any matter injurious to the public health when discharged into the sewers; and no matter which will injure the value of the sewage, or otherwise render more difficult its disposal at the sewer-outlet. No one of the above-mentioned substances shall be discharged into the sewers without the consent of the local authorities, and by approval of the Rivers Pollution Commission; but, with such consent and approval, manufacturers may be allowed to discharge into the sewers matters not injurious to their structure or prejudicial to the public health, upon payment of such damages as said authorities and parties concerned may agree upon.

SECT. 8. No town or city or private party shall introduce any sewers, or any system of public water-supply or sewerage, until their plans shall have been approved by the Rivers Pollution Commission.

SECT. 9. No dam shall be built upon any stream in this State, nor shall any dam now existing be raised, without the approval of the Rivers Pollution Commission.

SECT. 10. In any city or town where public sewers have been built, the local board of health shall, upon application from any parties, order any privy or cesspool to be abolished, and connection to be made with the public sewers, in the manner and under the penalties prescribed in chapter twenty-six of the General Statutes, whenever this can be done without violating preceding sections of this act: *provided* adequate sewers are not more than one hundred feet distant. And where such connections are made, the local board of health shall require it to be done according to such regulations as the Rivers Pollution Commission may deem necessary for the safety and health of the people. Such connection shall also be made in such manner as the sewer department, with the approval of the Rivers Pollution Commission, may require.

PROHIBITIONS IN CASE OF NUISANCES.

SECT. 11. The direct discharge into any stream of human excrement from privies, water-closets, or vessels of any kind, or of the waste water of washing soiled clothes from tenements is prohibited.

SECT. 12. Whenever any serious injury or offence exists from the pollution of any pond, or stream, or tidal water, within the State, the Rivers Pollution Commission may, if in their judgment the public health or the public comfort and convenience shall require, order any person or persons, or the authorities of any city or town, to cease and desist from such pollution, or to remedy the nuisance so created, or to cleanse or purify, by means satisfactory to said Commission, the polluting substances before being cast into said pond, or stream, or tidal water: *provided*, that, on any application to said Commission to exercise the powers in this section conferred upon them, a time and place for hearing the parties shall be assigned by said Commission, and due notice thereof given to the party against whom the application is made; and the order hereinbefore pro-

vided shall be issued only after such notice and hearing. In all such cases, the Rivers Pollution Commission shall consider the reasonable practicability of a remedy, as an important element in rendering their judgment. In complaints against cities or towns under this section of the act, said Commission shall recommend, when desired to do so, some plan for adoption, and shall advise the complainants as to the best course to pursue.

Public Buildings.

Sect. 13. All public buildings hereafter put up or occupied by the State must have their plans of water-supply, drainage, and disposal of sewage, approved by the State Board of Health, before they can be adopted. Said board shall also examine the water-supply and drainage of the various State institutions, and report what, if any, changes should be made in these respects.

Formal Proceedings.

Sect. 14. Any party feeling aggrieved by any decision of the Rivers Pollution Commission in accordance with the provisions of the preceding sections may appeal to the Superior Court for reversal or modification of such order or orders. But there shall be no recovery for alleged damages.

Sect. 15. Any person or persons violating any of the provisions of this law shall forfeit a sum not exceeding two hundred dollars for every month he or they continue to act in violation of said law, to be recovered by indictment before the Superior Court.

Sect. 16. Complaints for the violation of this law may be made by individuals, corporations, authorities of towns, or local boards of health.

Sect. 17. The Rivers Pollution Commission may, when in their opinion it is necessary, before giving their approval of any plans of water-supply or sewerage, employ a civil engineer of experience, and of eminence in his profession, to make the requisite examinations ; and the expense of such consultation shall be borne by the city or town to be benefited thereby.

Sect. 18. The Supreme Judicial Court, or any one of the justices thereof in time of vacation, shall have power to issue an injunction to enforce the orders of the Rivers Pollution Commission under section twelve of this act.

Sect. 19. This act shall take effect on the first day of January, eighteen hundred and seventy-nine; and all other acts and parts of acts inconsistent therewith are hereby from that date repealed.

Recommendations.

There are a few points to be borne in mind with reference to water-supply, drainage of houses, and sewerage, which have been suggested by the examinations of the Board in this State, and may properly be summarized here : —

1. The privy system, so common thoughout the State, by which filth is stored up to pollute the air, soil, and water, near dwellings, should be in all cases abolished.

2. Cesspools, unless with extraordinary precautions as to ventilation and prevention of pollution of soil and air, are little better, and should be given up for something less objectionable as soon as practicable.

3. Wells cannot be depended upon for supplies of wholesome water, unless they are thoroughly guarded from sources of surface and subsoil pollution. Some of the foulest well-water examined by the Board has been clear, sparkling, and of not unpleasant taste.

4. Where wells have already become polluted, and it is not practicable to dig new deep wells remote from sources of contamination, or to introduce pure public water-supplies, the storage of rain-water, properly filtered, is a satisfactory method of procedure.[1]

5. In small towns where public water-supplies have not been introduced, and, indeed, wherever water-closets are not used, some method of frequent removal and disinfection with earth or ashes[2] should be adopted in place of privies, by which it should be impossible for the filth to soak into the soil or escape into the air. Cemented vaults are not always to be depended upon, as their walls crack from frost or through settling of the ground ; and they thus sometimes become sources of pollution of wells, beside contaminating the air. Nor is the fact of a privy being on a downward slope from the well a sufficient safeguard ; for even then the direction of the subsoil drainage may be toward the well.

[1] This subject is treated in detail at a later page, by Prof. Nichols.

[2] There are several methods of accomplishing this object, as described in the seventh report of the Board. Galvanized-iron pails, with a free use of dry earth, and frequently emptied, as shown on page 185 of that report, are among the best.

6. Earth-closets, *with proper care*, may be satisfactorily adopted. But the earth, after having been once used, should be placed upon the land, not stored within doors and dried, to be again used; for, in the process of drying, there are emanations from it which are, perhaps, not less dangerous from the fact of their being imperceptible by the unaided senses, or through chemical examination. With earth-closets, a plan similar to that in use at the Pittsfield Hospital[1] may be well used for the chamber slops; and the kitchen waste may be utilized (with the chamber slops, too, if desired) in the manner used by Mr. Field and Col. Waring, already described. Less intricate methods are used in scattered dwellings, but with the effect of having the slop-water absorbed by the ground and taken up by vegetation so far from the house as not to involve a nuisance or danger to health.

7. Where water-supplies, water-closets, &c., are introduced, sewers should follow immediately, in most kinds of soil: cesspools should not be used, unless with extraordinary precautions. But with a few hundred feet square of lawn, the irrigation system by agricultural drain-pipes[2] is to be recommended, whereby the filth is at once taken up by the roots of grass. In all cases, of course, with or without cesspools, there should be thorough ventilation of the system of house-drainage, with disconnection from the main-outlet drain by means of either a ventilating pipe or rain-water spout between the sewer-trap and the house, and whose openings at the top should be only at points remote from windows and chimney-tops.

On the whole, a thoroughly satisfactory arrangement of this kind, if properly looked after, is in many respects to be preferred to connecting with public sewers.

8. While the water-carriage system is the least offensive to a refined people, the least costly in the end if on a large scale, and, when well managed, the least objectionable from a sanitary point of view, it should be remembered: (1), that in the case of towns and cities of moderate size its introduction involves the outlay of a large capital; (2), that the connections between houses and sewers can be made free from danger-bringing elements only with great care, and that usually

1 Described in an article on Cottage Hospitals, at a later page.

2 See page 20 of this Report.

from a want of such care they are often productive of a certain amount of harm, — a danger often very great, especially to children and delicate persons, since the possibility of the continuous ill effect on the system of a slight poison is not often recognized, and as few people can be induced to believe that any thing is a poison from which they cannot see immediate and striking ill results; (3), that the outlets of sewers, except near large bodies of water, generally involve a great deal of difficulty, and often of serious nuisance, from the fact that there is at present no really satisfactory way of disposing of the sewage, while a properly arranged system of frequent dry removal is not attended with especial danger to health, and may at any time be changed for better methods without involving any great pecuniary loss.

When sewers are built, or sewerage systems adopted, the work should be planned and carried out only by the best available talent: for badly constructed sewers are in many respects worse than none; and their proper arrangement and maintenance involve an amount of knowledge, skill, and experience, which are found only among men of unusual ability, who have had special opportunities for preparing themselves for their work.

Whichever of the three great disinfectants and destroyers of filth is used, — namely, *a sufficient quantity* of earth, water, or air and sunlight, — the essential process is the same: the effete matters are converted by oxidation and by chemical combination into products that are finally both harmless and inoffensive. In all three the oxygen is the most important agent, and burning, or oxidation, is the essential process. The most offensive gases, however, to a certain extent when in the earth, and to a less degree in the water, are absorbed mechanically; in the earth, too, the foul-smelling sulphuretted hydrogen unites with the iron found in most soils, forming an inert and inoffensive compound. But in all three, unless the amount of filth is proportionately very small, there are certain gases escaping, and what are called emanations, — possibly, too, disease "germs," — often so minute or diluted as not to be appreciable to our senses. It is the part of prudence, therefore, to have any and all of these processes reasonably remote from dwellings, and within certain limits to destroy all filth by oxidation, sewage-irrigation, &c., with as little delay as may be necessary.

Necessity of Supervision.

All of these points seem of such importance to the Board, that, in their opinion, no city or town should be allowed to embark upon costly schemes of water-supply and sewerage without having the benefit of advice from somebody who has had experience in such matters. There has therefore been inserted, in the draft of the law which precedes, a section providing that all such plans must be approved by the Rivers Pollution Commission. The matter of local drainage is also one involving great danger to the public health if not properly regulated; and provisions for that, too, have been made in the bill

COTTAGE HOSPITALS,

BY

Dr. J. F. A. ADAMS of Pittsfield, Mass.

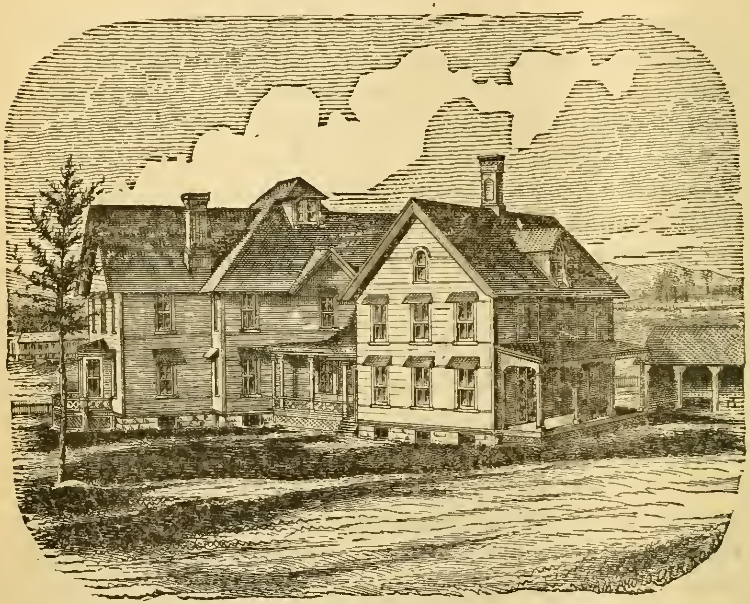
11

COTTAGE HOSPITALS.

THE value of small hospitals for country places has been so satisfactorily demonstrated in England, during the past twenty years, that the Cottage Hospital has there become a wide-spread and much-valued institution. The first of these was established at Cranleigh, by Mr. Napper, in 1859, and has since been copied in various parts of the kingdom, until the number is now not far from two hundred. Some of these are specially erected for the purpose, while others are simply dwelling-houses with or without alterations. They are generally smaller in the agricultural than in the manufacturing and mining districts. About a dozen have grown into general hospitals, with from twenty to thirty beds each; the others average between seven and eight beds each, the smallest having but two beds. They are generally very simply managed, the idea being to provide a pleasant, home-like retreat for the sick, where they can have the benefits of good nursing, diet, and medical attendance, without having to be sent away to one of the large county or city hospitals, a removal to which, in the case of accidents and acute cases, is apt to be impossible. The evils which sometimes result from the aggregation of a large number of sick under one roof are avoided in these smaller institutions, as shown by the death-rate, which is less than half of the average of the London hospitals. The cost is also found to be less per patient than in the large hospitals.

So useful and successful an institution cannot long exist in England without being adopted on this side of the Atlantic, and accordingly we find that here and there it is obtaining a foot-hold among us. Hitherto it has been the case in this country, that, while the great cities have been well provided with hospitals, the country towns and villages have had none, and even the smaller cities have been but

indifferently supplied. Thus in Massachusetts, while Boston possesses fifteen hospitals, with accommodations for over a thousand patients, there are in the rest of the State, exclusive of those for the insane and those belonging to the naval and marine services, but ten hospitals, with an aggregate of about two hundred and forty beds. Of this number all but two have been established during the past ten years, several of them no doubt owing their origin to an interest excited



HOUSE OF MERCY, PITTSFIELD.

in the minds of their projectors by the English Cottage Hospital movement. All of these are in cities or large towns of from twelve to fifty thousand inhabitants, scarcely any of them having that decidedly rural character which belongs to the English Cottage Hospitals, many of which are located in very small villages.

The following table includes the several hospitals in this State, outside of Boston.

	Population, 1875.	NAME.	Opened.	No. of Beds.	Character of Building.
Lowell, . .	49,677	St. John's Hospital, .	1868	60	Brick, specially erected.
" . .		Lowell Hospital, . .	1840	25	Wood, specially erected.
Worcester, . .	49,265	City Hospital, . .	1871	24	Originally dwelling, remodelled; two years ago, two new buildings.
Lawrence, .	34,907	Invalids' Home, . .	1877	6	Small dwelling, not remodelled.
" .		Cath. Orphan Asylum, .	–	18	Brick, specially erected.
Lynn, . . .	32,600	Lynn Hospital, . .	1875	10	Old dwelling, not remodelled.
Springfield, . .	31,053	City Hospital, . .	1870	12	Wooden dwelling, remodelled, with large addition.
Salem, . . .	25,955	Salem Hospital, . .	1874	20	Brick dwelling, remodelled.
New Bedford, .	25,876	St. Joseph's Hospital, .	1873	30	Dwelling remodelled.
Holyoke, . .	16,260	House of Providence, .	1874	10	Brick dwelling, remodelled.
Pittsfield, . .	12,267	House of Mercy, . .	1875	8	Wooden dwelling. New wooden building just erected; 13 beds.

Several in the above list possess more or less of the character of Cottage Hospitals, while others more properly come under the head of general hospitals. We have selected the House of Mercy at Pittsfield for a detailed description, because it has always been specifically called a "Cottage Hospital," all of its essential characteristics having been suggested by the institutions of that name in England, several of which had been visited and inspected by certain of the projectors of that at Pittsfield.

THE "HOUSE OF MERCY."

This Cottage Hospital was opened Jan. 1, 1875, and was the result of the united exertions of the charitable ladies of the town. These ladies held, in the previous September, a "Hospital Bazaar," from which, together with sundry donations, was realized a sum of money sufficient to enable them to furnish a building and to invest a fund of five thousand dollars, the interest of which was reserved for rent. They then effected an organization, obtained a charter from the Commonwealth, rented a pleasantly situated two-story dwelling-house in the village, furnished it appropriately, obtained the services of an experienced nurse who was made the matron, and invited the physicians of the town to give their services to the institution.

The corporation consists entirely of ladies; and its officers are a president, four vice-presidents, clerk, treasurer, corresponding secretary, recording secretary, and twenty-one directors, three from each of the seven churches working for this object; viz., First Congregational, Methodist, South Congregational, St. Joseph's Roman Catholic, German Lutheran, Baptist, and St. Stephen's Episcopal. These officers constitute a "Board of Control," in which board are vested the property and concerns of the corporation.

The building rented for the hospital was a two-story frame dwelling-house which had recently been enlarged, so that the front part was quite new. It was a pleasantly situated, sunshiny house, of ten rooms, which were used as follows: on the ground floor a reception or committee-room, matron's room, kitchen and two rooms for patients, each containing two beds; on the second floor, two rooms for private patients, each with one bed; one room with two beds, and two rooms

for assistants or servants. The hospital had, therefore, a capacity of eight beds. It was neatly and attractively furnished throughout, and its whole aspect was cheerful and home-like.

As no sewer had been laid in the street upon which the hospital was located, it was necessary to remedy certain sanitary imperfections which the house had in common with the majority of village houses; and this was accomplished at small expense. One of these alterations consisted in the ventilation of the waste-pipe running from the kitchen-sink to a cess-pool in the garden, by connecting it, by means of a tin pipe, with the kitchen chimney. The other was the complete revolutionizing of the usual privy, which in all country places has usually that primitive character which is a reproach to our modern civilization.

This was done by placing at one side a Wakefield's earth-closet, and at the other an arrangement for disposing of chamber-slops by an entirely new method, which has proved so successful and convenient that it merits description. A strong cask, or elongated tub, was constructed, open at one end, and largest at the open end, hooped with iron, and hung upon iron pivots, which were placed so near the centre of gravity of the cask that it could easily be capsized by a push from the hand. The cask was hung over an opening in the floor of the privy, boxed around, and with a movable cover. Into it were thrown the contents of all slop-pails, bed-pans, and close-stools; and immediately after, a sufficient quantity of dry earth or coal ashes was thrown in to absorb the whole. The earth was obtained from a bin, built upon the outside of the privy, so as to be filled from a cart outside, and with an opening at the level of the floor inside, from which the earth could be taken with a light shovel and thrown into the cask close by. The quantity of earth required to absorb a pailful of urine was found to be surprisingly small; and the disinfection was so complete that no odor whatever could be detected, except occasionally in the hottest days of summer, when, unless care were taken to dust the earth thoroughly over the sides of the cask, they would give off a faint ammoniacal odor. This was easily prevented by care; and the additional precaution was taken, in midsummer, of also throwing in disinfectants. To fill the cask, required from two to four

weeks, according to the number of patients. When full, it was easily capsized into a brick vault below, which also received the excrement and earth from the earth-closet. It was found that the contents of this vault never gave off a particle of odor; but, as a safeguard, a pipe was carried from it to the kitchen chimney for ventilation. Whenever the vault became full, its perfectly cleanly contents were removed, and used as a fertilizer. The credit for this method of disposing of chamber-slops belongs to Mr. C. A. Wakefield of Pittsfield, the patentee of Wakefield's earth-closets, by whom the apparatus was devised and constructed. It was thought best not to discharge these slops into the cess-pool, as the impervious character of the soil would require it to be frequently emptied. The swinging cask would be a valuable addition to any dwelling-house or institution similarly situated, and could very easily be applied. If necessary, its form could be simplified, and the cost thus reduced.

For three years the building just described has been used for hospital purposes. Its working-force has consisted of the matron, and a woman in the kitchen, such help as was requisite having been obtained from convalescents, and additional nurses having been provided by the ladies' committee, when necessary. The benefits of the institution, unlike most of the English Cottage Hospitals, have not been limited to acute cases and accidents; but chronic and incurable cases have also been received, several patients having literally been carried there to die. Persons able to pay are expected to do so, in proportion to their means, and those unable to pay have been taken free. Naturally it has proved that nearly all have been charity patients.

To obtain admission to the House of Mercy, it is necessary to obtain a certificate signed by a member of the ladies' "committee on admission," and by one of the two medical men designated as admitting physicians. Accidents are received without any certificate.

The physicians of the town have acted as attending physicians, in rotation; but pay patients are at liberty to select their own physicians. The number of patients during the three years has been sixty. Out of this number there have been nine deaths. This must appear a large proportion until it is known that of these nine cases, eight were hopelessly

sick on their admission, one of them being moribund from a railroad accident; while the ninth was a case of consumption in a young man who remained in the house nearly two years, acting as a man-of-all-work as far as his health would permit, and finally dying from the natural progress of his disease. The causes of death have been: Consumption, 3; cancer of stomach, 1; heart disease, 1; inflammation of brain, 1; pneumonia, 1; leucocythæmia, 1; railroad accident, 1.

To prevent the house from becoming too much of a home for chronic invalids, the ladies have made the rule that no patient shall remain more than three months, unless by a vote of the board of control.

No special dietary has been used; "full diet" being understood to mean an abundance of good food, in such variety as is found on the table of any well-fed family. Extra diet is prescribed as required. The house has no dispensary; but an arrangement has been made with the druggists, by which medicines are provided at a reduction from their usual charges, and prescriptions are sent to each, in rotation, for two months at a time. The ladies have proved the most liberal of providers, furnishing every thing which the physicians think needful for the sick.

The income of the institution has been derived, in part, from the interest on the fund, which has been just enough to pay the rent of the house, while the remainder has been raised by the persistent efforts of the ladies. The sources of income, aside from the fund, are life-memberships, annual subscriptions, donations, "Hospital Sunday," various entertainments, and patients' payments. Beside donations of money, much is contributed in the way of provisions, clothing, &c.; and several families agree each to send a "basket" once a year, this to contain such provisions as are most needed. The word "basket" is used in a very general sense, as it may assume any form, even to a barrel of flour. The total expenses of the house, including rent, have averaged somewhat less than $120 per month.

Early in the present year the ladies became convinced that the house they have rented is unsuitable for their purpose, being on hard-pan soil, which renders the cellar damp, in spite of attempted drainage; having imperfect ventilation,

and being without many essential conveniences. They therefore decided to build a suitable structure, and took the first step by purchasing a triangular lot of land, at the intersection of three streets, at the northern limit of the village. The lot measures three-quarters of an acre, and the soil is a coarse, dry gravel. Upon this they have erected a hospital for thirteen beds, capable of holding more if necessary. It is a two-story frame building; or, more correctly, two separate buildings connected by a short corridor.

On account of the triangular shape of the lot, these two buildings are placed obliquely to each other, so as to make them parallel with the two streets upon which they respectively front. The principal building contains the reception or committee room, matron's room, and twelve rooms for patients. There are no general wards, it having been decided to have single-bedded rooms only. This building also contains the bath-rooms and water-closets, which are so concentrated in the two stories, as to be surrounded with a brick wall, forming a square tower within the building, lighted by windows to the east. Every room in this building has an open fireplace, connected with a large flue in one of the four massive chimneys. This building fronts to the north-west; the other, or smaller one, is connected with it by a covered corridor, which, running east and west, has its south side composed entirely of windows looking out upon a south piazza, sheltered by the two buildings from both east and west winds. The lesser building contains, on the lower floor, kitchen and dining-room; on the upper floor, servants' rooms, and an "isolated ward" for contagious or infectious cases. The dining-room, which will also be a convalescents' room, is at the south-east corner of the building, and has glass doors opening upon a pleasant piazza, which occupies the length of the east side of the building.

The main entrance is placed at the middle of the front of the main building, and is sheltered by a large porch. There is a second entrance from the south piazza, and a back-door to the north. On entering the front-door, the matron's room is on the right hand, and the reception-room on the left. A passage-way runs across the building, continuous with the corridor beyond. This passage-way is intersected by another running through the centre of the building, from north to

FIRST FLOOR PLAN.

C.T. RATHBUN, ARCHT. PITTSFIELD.

south, terminating in a bay-window at the southern end. Outside of the bay-window is an enclosed balcony. The stairs are placed at the rear of the longitudinal passage, in the centre of the building.

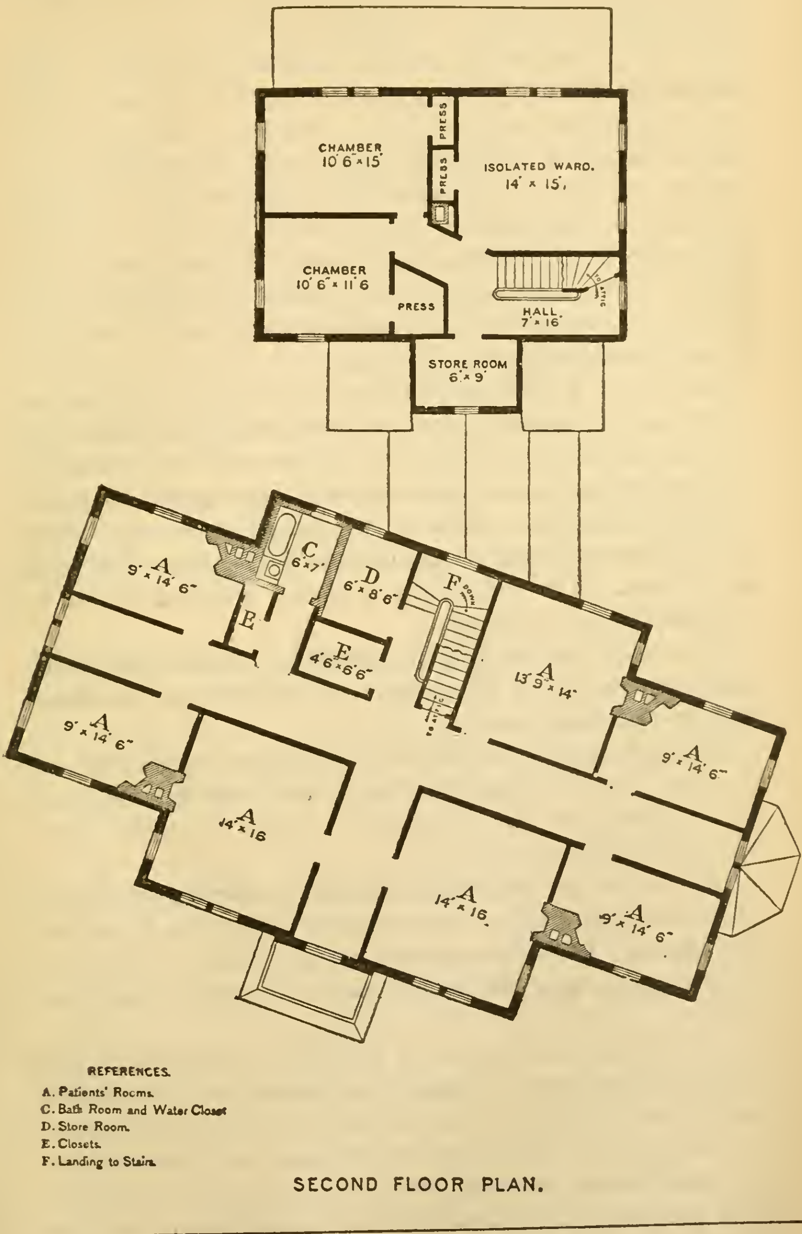
The length of the main building is 66 feet 6 inches; its width is 37 feet 9 inches at the centre, and 26 feet at the ends. The reception and matron's rooms measure each 14 x 16 feet. There are five rooms for patients on the lower floor, of which four measure 9 x 12 feet, and one 9 x 13 feet 9 inches.

On the plan of the first floor, the letters have the following significations: A, patients' rooms; C, bath-rooms and water-closets; D, store-rooms; E, closets; J, matron's room; K, reception-room; L, lavatory; M, dining-room; N, kitchen; O, pantry; S, outside entrance to laundry in the basement under the kitchen; T, sinks; U, slop-sink; V, wash-bowls; W, bath-tubs.

On the second floor there are two rooms measuring 14 x 16 feet, one 14 x 13 feet 9 inches, and four 9 x 14 feet 6 inches. The height of the lower story is 9 feet 6 inches, and of the upper story 9 feet. The floor of the upper story is deadened with brick and mortar. The walls of the whole building are back-plastered, to add to their warmth, and further protected by builder's paper placed beneath the clapboards; the most exposed parts having, in place of the paper, large sheets of heavy pasteboard, similar to binder's board. All of the windows are large and high, and hung with weights. The fireplaces are handsomely made with pressed brick, surmounted with wooden mantles, and are provided with flat iron grates for burning wood.

There are two bath-rooms on the lower floor, each containing a water-closet, one for men and one for women. Each is reached from the passage-way, through a lavatory containing set wash-basins; thus placing two doors between each water-closet and the passage-way. A slop-sink is placed in one of the lavatories. One of the bath-tubs is placed on rubber rollers, so as to be trundled into the patients' rooms if desirable. On the upper floor there is but one bath-room, though space is provided for another, should it be required.

All of the soil-pipes are ventilated by means of a vertical six-inch iron pipe, which enters one of the chimneys just



REFERENCES.

A. Patients' Rooms.
C. Bath Room and Water Closet
D. Store Room.
E. Closets.
F. Landing to Stairs.

SECOND FLOOR PLAN.

below the roof. The bath-rooms have ventilators. The walls are plastered throughout the building; the plaster being treated with three coats of oil paint, which allows them to be thoroughly cleansed. A pleasing variety of tints is employed, which adds to the attractiveness of the interior. The building is thoroughly heated throughout by steam. The high roof affords a large, light, and well-ventilated attic, which, having a good floor, could easily be utilized as a ward if necessary. The smaller building has also a roomy, well-lighted attic, likewise capable of being used as a ward. The cellar is high, light, and dry, and extends under the whole of both buildings and the connecting corridor. The building is supplied with the public water-supply from Ashley Lake, and is lighted with gas.

One of the rooms opening from the reception-room is intended as an operating or clinic room, and is provided with hot and cold water. As no sewer passes sufficiently near to the hospital to connect with it, two large stoned cess-pools are placed five rods north of the building, one connecting with the water-works of the main building, the other with the kitchen. The soil, being a coarse, bibulous gravel, is well adapted for cess-pools.

Externally the building is tastefully painted, the walls being gray, with buff trimmings; and the shingled roof and window-caps slate-color.

The corner-stone was laid with appropriate ceremonies on the first day of September, 1877; and the building was first occupied Jan. 15, 1878, just three years from the opening of the temporary house.

The cost of the building, including steam apparatus and all other extras, will be about $8,500, beside the lot, which cost $1,000. The ladies have raised the money through donations and entertainments, so that the hospital is free from debt.

It is hoped, that, to persons desiring to establish cottage-hospitals elsewhere, the foregoing history and description may prove of service, — not as a model, but as a suggestion; for the special wants of each locality must call for such special modifications as would prevent any two cottage-hospitals from possessing more than a general resemblance. Such institutions are needed in many towns of this Commonwealth.

Circulars of inquiry have recently been sent by the State Board of Health to their correspondents in the State in every city and town of ten thousand inhabitants and upwards; and, in each case where no hospital exists, the correspondent states, that, in his opinion, such an institution is needed. No doubt they are now, or will eventually prove to be, needed in even smaller places. In England it is found, that, in agricultural districts, one hospital bed is required for each thousand of population, while in manufacturing and mining districts the proportion must be somewhat larger. In this country it is probable that the proportion may be less, owing to the greater prosperity of the laboring classes, especially in the rural districts. Moreover, in the minds of the majority of people, the idea of a hospital produces a certain feeling of dread which can only be overcome by education. This feeling can be in great measure counteracted by making these institutions smaller and more widely distributed; and especially by giving them the shape of simply-managed, home-like cottages, which, while possessing all the essential elements of a hospital, are divested of the formidable proportions of those in the cities.

To persons desirous of investigating the subject of cottage-hospitals, the following English works are specially recommended: "Handy Book of Cottage Hospitals," by Horace Swete, M.D., 1870; and, "The Cottage Hospital: its Origin, Progress, Management, and Work," by Henry C. Burdett, 1877.

The following have also been published: "On the Advantages derivable to the Medical Profession and the Public from Village Hospitals," by Mr. Napper of Cranleigh, 3d ed., 1866; "Cottage Hospitals: their Objects, Advantages, and Management," by Edward J. Waring, M.D., 1867; "Remarks on the Establishment of Cottage Hospitals," by F. H. Harris, F.R.C.S., 1866; also an article by Dr. Wynter in "Good Words" for May 1, 1866.

DANGERS FROM COLOR-BLINDNESS,

BY

B. JOY JEFFRIES, M.D.,

OF BOSTON,

OPHTHALMIC SURGEON, MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY.

DANGERS ARISING FROM COLOR-BLINDNESS.

It is quite commonly known, that there are certain people in the community who cannot distinguish ripe cherries or strawberries from leaves except by their form. It seems to be about equally well recognized, that this is only a sort of curiosity of no special importance to the community at large. When, however, it is remembered that the color-blind individual may be the engineer of a train running nearly a mile a minute to "catch up time," and that the passengers' lives, not to speak of their property, are dependent upon his knowing whether a switch is open or shut, or a draw up or down, by his instantaneously distinguishing between a red and a green light, then the community's attention may possibly be aroused. Or, if another equally blind individual is pilot on a steamer, and cannot say whether the light directly ahead of the lives and property dependent upon his eyesight is *red* or *green*, and hence cannot know which way the sailing-vessel or steamer is moving in order to avoid collision, then the mere curiosity part of color-blindness sinks into insignificance in comparison with the danger arising from it. The community then awakens to a sense of the importance of asserting its rights. We may, however, suppose that the steamboat has several persons on the watch at the same time. This, however, would not prevent the helmsman of the heavily-loaded coaster, perhaps the only man on deck, if he is color-blind, from mistaking the steamer-lights, confounding the green and red; or he may miscalculate their distance, if he is partially color-blind. Such cases as these, which are sure to come into the courts on the question of damages, show us the dangers arising from this visual imperfection.

The mortification, inconvenience, and loss of position or employment, from the lack of power to choose proper or appropriate colors in dress and costume, to distinguish and

match colored goods, to mix or use colored pigments, will not be here dwelt on. The *dangers* only to which the community are subjected from color-blind railroad employés and pilots will be explained in this article, and how and why these should be avoided by the action of the community in protecting itself. For instance, an engineer has run on one road for some five or ten years without accident of importance. The superintendent requires him to pass examination by an expert, who finds he is markedly red-blind, and shows it most convincingly to the officials of the road. It becomes known; and they then do not, of course, dare to keep him in his place. He is dismissed, to protect the community from danger.

Color-blindness is a partial or total inability to appreciate, as the normal eye does, one or more of the three so-called base colors. Scientists are at present pretty well agreed in regarding as the three base colors, red, green, and violet, or blue-violet. A large proportion of those who are color-blind are so in reference to red; next come those who are green-blind; and but rarely do we find persons violet-blind. Individuals have been examined who were blind to two of the three base colors; and there is record of totally color-blind persons, i. e., who had only an appreciation of light and shade. It must be distinctly remembered, that color-blindness does not necessitate any lack of power of sight as to form. On the contrary, the color-blind may possess extraordinary visual power, much above the normal eye as regards form, and may be able, for instance, to read letters much farther off than a person with a normal eye, not color-blind. It may here be observed also, that a person may be so blind as to form as not to be able to find his way about, or go alone, and yet have perception of colors and shades. To the color-blind all *mixed* tints, in the proportion which they contain his faulty color, will appear so much the darker. Where we see color, he simply sees the absence of it, if we may so say; that is, an object of his faulty color appears to him as gray does to the normal eye. A red-blind person places a scarlet and a light gray together, as giving him the same impression. He will put on red pants or vest as readily as gray, or wear complacently a red and a green glove. When a red-blind person looks at the spectrum, or series of

colors from light passed through a prism, he will, towards the red end, fail to see any color where the normal eye continues to see brilliant red; and the same will hold of the violet-blind, in reference to the other end of the spectrum, &c. This has an important bearing on the danger from color-blindness, as we shall hereafter see. A person who is red-blind cannot distinguish that color from green; or, if blue-violet-blind, that color from yellow; or, if green-blind, that color from its complementary one, red. Hence we have practically to deal with red-green blindness and blue-yellow blindness. These are, however, the very colors of necessity used on our railroads, sailing-vessels, and steamboats, as well as in many lighthouses.

It is just one hundred years ago that cases of color-blindness were made public by Joseph Huddart. It was not till 1794 that the English chemist Dalton published an account of his own case, he being red-blind. Pierre Prevost of Geneva, in 1827, first called color-blindness Daltonism, and those so afflicted Daltonians. It is now, however, generally agreed to give up this use of so distinguished a man's name; and, as has been claimed, Daltonism should mean rather the doctrine of indivisible chemical atoms, and Daltonian a believer in such.[1] In 1837 Professor A. Seebeck was the first to examine a *number* of color-blind, and classify their troubles. He also first showed that there were *degrees* of color-blindness, a very important practical point.

Dr. George Wilson of Edinburgh, in 1855, in his book[2] on color-blindness, says, "My own special attention was directed to the subject from the blunders which I found my chemical pupils make in reference to the colors of compounds. After making every allowance for imperfect exposition on my part, and insufficient attention on the part of my students, and after also making a large deduction from inaccurate answers on the score of imperfect remembrance and inability to name colors, I still found, both in the laboratory and lecture-room, that many a pupil was puzzled to describe the changes which occur when an acid or an alkali acts upon a vegetable color-

[1] I use, therefore, the word "color-blind" throughout this article, instead of "Daltonism."

[2] I will not dwell on the literature of color-blindness, but refer to the list of works at the end of this paper, in the Alphabetical Bibliography.

ing matter, although to a normal eye these changes are of the most marked character; and that in general I could count with little confidence upon accurate answers to questions regarding the colors of bodies."

Dr. Wilson found two color-blind among his class of students, and subsequently had opportunity of examining many others.

I shall in this article often quote from Professor Wilson's book, but will here give his closing sentences: "The professions for which color-blindness most seriously disqualifies are those of the sailor and railway servant, who have daily to peril human life and property on the indication which a colored flag or lamp seems to give. Fortunately a ship is seldom under the guidance of a single person; and in her Majesty's vessels the color-signal men are selected from a large number, and are ascertained to have a quick eye for color. In merchant-ships the choice must necessarily be made from a much smaller number; and the appalling yearly list of lost vessels which appears in our Wreck Returns awakens the suspicion that more than one of these fatal disasters may have resulted from the mistaken color of a lighthouse, beacon, or harbor-lamp, which on a strange coast, and with perhaps the accompaniments of a snow-storm or a thick fog, has been wrongly deciphered by a color-blind pilot.

"On railways the danger attending mistakes of signals is much greater than at sea; especially in this country (England), where trains travel at a very high rate of speed, and succeed each other at very short intervals. The most marked peculiarities of the color-blind are shown in mistaking (1) bright red for green, (2) dark red for brown, (3) red for black, and (4) dark or light shades of all colors for each other. The caution signal *green* is thus liable to be mistaken for the danger signal *red*, and the latter (when it appears black) not to be seen at all. . . . I am happy to say that the publication of my papers has induced the Great Northern Railway Company to require that in future all their porters shall be tested as to their freedom from color-blindness before they are admitted."

Dr. Wilson's book and his efforts did not bear the fruit they deserved. No law has been passed by Parliament requiring

examination for color-blindness of all railroad employés in England, though warning has been also given there by Professor Tyndall, and across the Channel by Prevost, Noel, Favre, and Feris. In fact, twenty-two years after Wilson wrote and talked, a public journal, after speaking of the then recent accident at Arlesey, said, "Hence, a systematic examination of the eyesight of those entering these services is imperatively necessary; and a definite report on the subject should be required of every examining surgeon. This would add but little to his labors, for the method of detection of the fault is sufficiently simple: the colored letters of Snellen's test-types[1] meet every need. If this is generally carried out, the public mind may rest contented; for thus the congenital form of the color-blindness would be effectually recognized, and only those cases of loss of power of perception of color which come on gradually, and are symptomatic of disease of the optic nerve, or other parts of the nervous system, would remain undetected. These cases are relatively so few in number, and associated with so much general impairment of vision, that they need excite no alarm."

After the accident at Arlesey, a number of the English railroad surgeons reported that they had rarely found color-blindness amongst the employés. Now, this is readily explainable when we come to inquire as to the *methods of examination* for color-blindness in that country; for we find they all depend upon the *naming of colors* by the examined. Till such methods as Wilson and Seebeck used, and which are now generally employed throughout Europe, are adopted and carried out by specialists or by surgeons particularly instructed by specialists, color-blindness will not always be detected in railroad employés or sailors, and accidents from its existence will occur. An English journal well says, "The testing itself is, however, or rather should be, a scientific affair. It cannot be hastily settled by showing a man a few pieces of paper, and asking him to name the colors." Mr. Mason of Edinburgh would quiet public anxiety by saying in "The London Times" of Dec. 28, 1876, that "care is taken to examine on most of the lines." I would ask what tests are used, when any are used. Certainly the attempt to

[1] This test has since been proved insufficient.

prove or disprove color-blindness by Snellen's colored test-letters is simply ridiculous. It is, however, gravely recommended in what I have above quoted. I should state that I cannot here discuss this point at greater length, as I am of course to enter into no exposition or explanation of methods of examination for or detection of color-blindness.

I have been, by experiment and observation, reluctantly convinced that it is impossible to substitute form instead of color for railway and marine signals; and also am convinced that the best color for night is *red*, to mean danger, whilst black and white can be used during the day. When another color must be used, the best seems the complementary *green* by night. Black and white, or in other words form, can always be used by day. Now, this seems to be what the railroads, especially of this country, are gradually coming to. Absolute safety, therefore, depends on the detection and refusal of all color-blind employés.

The attention of railroad managers, and also that of the community at large, has been repeatedly called to the great danger likely to arise from color-blindness. I would, for instance, refer to Noel, in the "Courier des Sciences." And I would particularly call attention to the efforts of Dr. A. Favre of Lyons, France. I cannot do better than quote from the *résumé* of his memoirs. He says, "I have proved by facts personally observed from 1855 to 1873–7, the necessity of testing for color-blindness all candidates for railroad service, and the exclusion of those who are *red-blind;* also the necessity of specially examining employés who have been injured about the head, those recovered from severe illness, smokers and drinkers. I call also for the periodic examination of all in active railroad service. The majority of these precautions, adopted on the Lyons road since 1857, have been gradually enforced on other lines, and quite recently also on the Belgian roads." "Feb. 8, 1875, I called the attention of the 'Conseil de Santé des Armées' to the use of the colored signals employed in war, and the necessity of testing those giving or receiving orders by colored signals." "In February, 1875, I called the attention of the Medical Society of Lyons to color-blindness caused by injuries." "On Nov. 4, 1875, I addressed the Medical Society of Marseilles in reference to color-blindness in navigation. My conclusions were

adopted, and communicated to the marine authorities of the port, and the Minister of Marine. At the same time, the Academy of Sciences and Letters of Lyons voted to call to my publication the attention of the Ministers of Public Instruction, Public Works, War, and Marine."

Thus has not only the railway service been appealed to, to guard the community from danger, but the marine service also. Dr. Feris says, "If color-blindness is considered a grave danger on railroads, how much more on the sea! Colors are very important to the mariner: the flags, the side-lights, and even the lighthouses and buoys and beacons, present various colors. It is impossible for a helmsman or a signal-man to interpret or transmit signals if they have no appreciation of color. Errors with flag-signals are not so likely on board of vessels, as they are employed in daylight, and more often controlled by officers in charge. But the men at telegraph stations are often alone, not under observation, and hence more likely to make mistakes. National flags may be mistaken, but more especially the white, red, and green Bengal lights used as night-signals." "If good color-perception is necessary for a helmsman, how much more for the commander of a vessel! The increase of collisions at sea is an indisputable fact. How many remain unexplained, or referred to another cause, which are no doubt due to the color-blindness of a single man! All vessels must now from sunset to sunrise carry a *green* light on the starboard and a *red* one on the port side. These show not only the position, but also the direction of movement, of the vessel." "We can readily imagine cause for collision if the officers or watch of either of two vessels approaching are color-blind."

As the magnitude of the danger depends, of course, on the frequency of the defect, it becomes important to know in what proportion of the community it is likely to occur. Very variable statistics are given by different observers, depending largely upon the methods of testing for color-blindness; the more thorough and scientific these latter are, the greater being the number of color-blind individuals found. Mistakes of excessive ratio reported are now better understood and avoided, since we know color-blindness runs in families, and is hereditary. An observer might thus find 10

out of 40 individuals examined, color-blind. Let us glance at the statistics, such as they are, reported by the earlier observers. Dalton found 8 to 12 per cent. Professor Pierre Prevost, 3 to 5 per cent. Professor Kelland of the Edinburgh University found among 151 students 3 "thorough Daltonians," and several less well-marked cases. Wilson again found 2 among 20 students, one among 47 other students. On the Edinburgh police, *five* among 158. Dr. Rowe at the Morningside Asylum found 5 among 42 male attendants. These I quote from Wilson. Seebeck found 5 color-blind among 100 students. Professor Allen Thomson met with the same result as Dr. Wilson, as also D'Hombre-Firmas in France, and Professor Dove in Berlin. Dr. Wilson also examined a large number of soldiers, who together with those above spoken of as tested by him amount altogether to 1,154 persons. Amongst these all, 65 were color-blind, an average of 5.6 per cent, or one in 17.7. The red-blind were most numerous throughout all these. This proportion has been now admitted by Professor Helmholz. Wilson said in 1854, "The statistics of color-blindness are as yet very imperfect, and do not include females; but there is every reason to believe that the number of males in this country (England) who are subject in some degree to this affection is not less than 1 in 20, and that the number markedly color-blind, i.e., given to mistake red for brown, brown for green, purple for blue, and occasionally red for black, is not less than 1 in 50. We may thus, according to our present knowledge, regard *two* in every hundred of the community as *seriously* defective in their perception of color." Dr. Goubert estimates 1 in 25 color-blind. Dove in his memoir of 1872 gives the following figures: Among 860 men, there were 40 color-blind, 4.65 per cent, or 1 in 21.5; among 611 women, 5 color-blind, or 0.82 per cent, or 1 to 122. Among 1,016 scholars at the Lyons Lyceum he found 16 color-blind for red and green, on a visit made in April, 1877.

The last report of Dr. Favre, of the Lyons Mediterranean Railroad, gives the results of examinations of railroad employés since 1855; it shows also how more careful tests discover a greater proportion of color-blind persons. Dr. Favre up to 1855 had examined about 5,000 candidates for railroad work, and rejected more than 50 for being *red-blind*. He had

not, unfortunately, kept accurate records. From 1855 to 1864 he noted 8 color-blind only, which number does not correspond with the number of men examined. From 1862 to 1872, among 1,196 persons, he refused 14 color-blind who could not tell red. From May, 1873, to July, 1875, his examinations were more particular and exact; and he found among 1,050 persons seeking railroad employment, 98 who made decided blunders or hesitated; 10 were refused for being red-blind. His new series since 1875 comprises 600 examinations: the results of these he has not yet sent me (January, 1878). 728 men already in employment were examined in 1872–73. More than one-third of these had been previously tested for color, and the red-blind eliminated. Of these 728, 42 either made mistakes or repeated hesitations. Among 224 conductors examined by Dr. Favre and M. Git, 14 were found decidedly color-blind. In 1874 he found 4 color-blind among 75 office-clerks; the same year, 24 among 65 firemen at the Perrache gas-works. At the Ouillins works, among 148 workmen, whom he examined in August, 1877, 82 told the five elementary colors without error or hesitation: 56 either hesitated or made mistakes. May 7, 1877, among 155 students at the veterinary school at Lyons, Dr. Favre found 19 hesitate or make mistakes. Examining with Capt. Bellecour 268 sub-officers and men of the 16th line, he found 105 color-blind or color-deficient. Among 138 men of the 22d, 23d, and 99th line, M. Paul Guillot found 37 color-blind. Lt. Gallet of the 26th Artillery, in garrison at Mans, examined 116 young soldiers, and found 32 who hesitated or made mistakes on a color-scale of 15 shades. Lt. Lautheaume found 40 color-blind among 132 men of the train of the 26th artillery. The average among this series of 654 young soldiers was 32.72 per cent. Dr. Mourand, among 200 men of the Lyons station, found 7 color-blind. Dr. Favre says his colleague must have noted only the most marked cases.

Dr. Feris, in his pamphlet and more recently in a communication to Dr. Favre, reports having examined 775 officers and sailors, amongst whom he found 75 color-blind; 19 wholly confounded *red* and *green*. The average of this series is 10 in 100. Of all the adults Dr. Favre examined, the average was 16.84 to 100. He says, "The results will vary greatly, being dependent on many circumstances and pecu-

liarities I shall hereafter notice; but we may be assured, that in France the color-blind amount to 10 in 100 of the adult males." I must for brevity omit Dr. Favre's similar reports as to children and the aged, as well as the interesting results he obtained from observers in the French domain of Northern Africa.

Dr. Favre says, "The study of color-blindness interests at least a tenth of our population (France). This very large proportion gives us the measure of the chances of error the color-blind run in the various industries where good color-perception is necessary or useful. It does not, of course, give us an exact idea of the chances of accident at sea and on railroads, on account of the accessory circumstances which aid the color-blind in his embarrassment; but it shows us plainly how numerous the chances are."

My friend Dr. Edmund Hansen, a distinguished ophthalmic surgeon of Copenhagen, Denmark, writes me June 24, 1877: "The railways of Denmark are in the possession of two parties: one is a private company which owns the railways of the larger island called Sealand, and of the adjacent smaller islands Lolland and Falster; whereas the railways on the island Tyen and on the peninsula Jutland belong to the government. The investigation for color-blindness has just been completed by the private companies; on the government railways it will be done in the course of the summer. (I will give you the results of the private company, and shall send you the other when the results have been made known.) The examination on the Sealand, Lolland, and Falster roads has been made according to the method of Professor Holmgren of Upsala, Sweden. 1,084 persons were examined, of whom 50 were women. Of this number, 31 men, or 2.87 per cent, were color-blind, all congenital cases; none of the women were color-blind. Of the 31, 10 were perfectly color-blind, 21 imperfectly. Of the perfectly color-blind, 6 had red-blindness, 4 green-blindness. Their occupations were, 2 station-masters perfectly green-blind; 1 engineer perfectly red-blind; 1 train-conductor, 1 fireman, perfectly green-blind; 4 porters, 3 blacksmiths, 7 railway guards, of whom 2 were perfectly red-blind; 2 assistants, 1 pupil, perfectly red-blind; 1 *concierge*, 2 foremen, of whom 1 was perfectly green-blind; 4 workmen on station, 1 perfectly red-blind; 2 extra conductors,

1 perfectly red-blind. I have had the opportunity of examining a large number of the individuals who enter the Royal Navy: I hope some day to be able to give you some statistical information on this point, if you still take an interest in it."

Dr. Johann Hjort of Christiana, Norway, writes me April 20, 1877, "In answer to your letter of the 23d, I must own, that we are not yet so far advanced as to have any laws about the examination of railroad employés and pilots as to color-blindness. I am aware that railroad surgeons have made such examinations in private; but there is nothing published about it."

Professor A. Quaglino of Milan, Italy, writes me Aug. 11, 1877: "I do not know whether there are any statistics of color-blindness published in Italy, though I am sure that all the railroad employés are subjected to a rigorous examination in reference to their color-perception. It has been generally believed that color-blindness is more rare in Italy than in Germany, England, or France; but I much doubt this, as there has been little research among us, and I think that a large amount will be found were it carefully looked for."

Professor F. C. Donders of Utrecht, Holland, has lately, with the assistance of twelve physicians and ophthalmic surgeons, whom he had specially instructed in a method of his own, examined 2,300 employés on the Holland roads. He found 152 of these color-blind. These he subsequently, with his assistant Dr. Bouvin, still more carefully tested, thereby confirming his previous results.

Dr. J. Stilling of Cassel, also, writes me, Dec. 6, 1877: "I have but once had opportunity of examining railroad employés, about 400 in number; of these 6 per cent were color-blind." He has invented and published some new tests for the imperfection, and says: "A number of the railroad corporations are turning their attention to color-blindness, and the time is not far distant when we shall have official and complete examinations of all employés."

The Bavarian government railroads have ordered a similar examination for of all their employés. Unfortunately their printed instructions were not drawn up by a specialist, one familiar with Professor Holmgren's method, and are hence severely and very properly criticised by Professor J. Michel

of Erlangen. He says he has employed Professor Holmgren's method, and can wholly recommend it.

It is stated that "an optical examination has been ordered by the Minister of Ways and Communication, at St. Petersburgh, of all persons connected with Russian railways, in order that their power of distinguishing colors may be tested. It appears that the order has been issued in consequence of the startling results lately obtained from a similar examination of railway employés in Finland."

Dr. A. Lederer has lately found 63 color-blind persons amongst 1,312 men of the Austrian navy, or 4.8 per cent.

In the statistical memoirs of the United States Sanitary Commission published in 1869, the compiler, Dr. B. A. Gould, says, "Few observant persons, in our own community at least, can have failed to be frequently impressed by the comparatively large number of persons who are more or less unable to distinguish between colors the most strikingly contrasted. The ordinary intercourse of daily life does not usually attract attention to this peculiarity; but, when any accident has brought it to our notice, we are surprised at discovering its existence in some familiar acquaintance in whom it had never occurred to us to suspect it. Persons who cannot distinguish ripe cherries upon the tree, or strawberries on the vine, by their color, are far more numerous than would be suspected by those who have given no attention to the subject; and unless some grotesque incongruity in costume, or some remarkably inaccurate description of the color of a well-known object, compels our notice, we remain unaware of the imperfection. Serious misunderstandings or calamities have been reported in the army, resulting from mistakes in the color of green and red lights by officers of the signal corps, themselves not fully aware of their failing in this respect; and cases have occurred when ludicrous and even disastrous results have followed the use of a badge of precisely the wrong color." Instructions were issued to test for color-blindness; and in the reports received, "the descriptions of the irregularities manifested in distinguishing colors are in general neither complete nor adequate, owing probably to insufficiency of the instructions given." Among 8,831 white men, 161 were found color-blind, equal to 0.02. This small ratio is of course due to the crude method of examin-

ing, which would only detect the most marked cases of color-blindness. Dr. Gould says, "Notwithstanding the incompleteness of the descriptions returned, and the consequent inadequacy of the classification, the well-known fact is distinctly manifest, that the most usual form of color-blindness is that which fails to distinguish between the green and red, and that the confusion of colors sometimes embraces the other half of the spectrum, and sometimes its entire range."

The great variation in the ratio of color-blind persons, reported by different observers, is readily explained by differences in the accuracy of the method of testing.

In testing color-perception by the sun's spectrum thrown on a white surface, the color-blind observer will see the color he is deficient in over a smaller surface. Dr. Ed. Ræhlmann, in Halle, reports the test of 70 people with the sun's spectrum. He found only 30 of them saw the red normally: the others varied in their red perceptive power. He tested only 20 as to the violet end of the spectrum, and found remarkable shortening of the visible portion for this end also. He noticed also that when the red end of the spectrum was shortened, the violet was also reduced, limiting the spectral row of colors on both ends.

I have recently employed Professor Holmgren's method in testing 611 instructors and students of the medical department of Harvard University and the Institute of Technology. Amongst them I detected 30 color-blind, being very nearly one in twenty, — not a large ratio for the whole community.

In a society of some sixty or seventy gentlemen, after I had spoken on this subject, three persons, besides one other whom I knew was color-blind, reported to me that they suffered from this visual imperfection. Still another told me his child was color-blind, as had been his wife.

I have perhaps quoted enough to show by statistics, and by the precautions railroad corporations in Europe are taking, the extent to which color-blindness prevails. But I should quite fail in giving the subject due prominence as to the prevalence of color-blindness, the value of scientific investigation in detecting it, its danger for the community, and the success of true methods of testing in convincing railroad people of all this, &c., were I not to quote from

Professor Holmgren's work. His method of examination has been generally adopted wherever railroad surgeons are testing the employés, and consists in the use of worsteds of various colors, whereby the person examined does not name the colors at all, but simply selects them by comparison with the test. By it, a number of eyes can be tested for color-blindness in a relatively short time, whilst it does not call for any special intelligence on the part of the person examined. Its operation, moreover, requires but little necessary preparation or apparatus. It is on the principle of one used more than twenty-two years ago by Dr. Wilson, but since neglected.

I take the liberty of reproducing from Professor Holmgren's book (translated) as follows: —

"In a case called the Lagerlunda, arising from a railroad accident at Lagerlunda, in Ostrogothie, Nov. 15, 1875, and which excited great public attention, there was evidence leading me to suppose that color-blindness was one of the principal causes of the disaster. This led me to think that control should be exercised among railroad employés as to color-perception.

"In June, 1876, I had an opportunity for testing this matter. By the courtesy of Major-Gen. von Knorring and Major Rudbeck, I was permitted to examine 2,200 men of the infantry and dragoons of the guard in camp in Upland. The extreme simplicity of the method was shown, and its ready adaptation both as respect rapidity and certainty. The examination averaged one minute to a man, often less; and, by the improved method adopted, we detected also with certainty all those partially color-blind. From this examination we learned, in reference to the existence of color-blindness among the population of the province, that out of the 2,200 men, 11 were red-blind, 17 could not perceive green, and 1 violet (?); 31 besides were *incompletely* color-blind in accordance with my classification. There were, then, 60 defective, or 2.7 per cent. The cases of 'feeble sensation of colors' are not here included.

"July 14 of the same year, I had opportunity at the Scandinavian Medical Congress assembled at Gothembourg, to describe my method, report the results of its employment, and also to express my views as to the necessity of taking measures on a large scale in reference to the detection of color-blindness, especially among railroad employés. In consequence, the Congress voted unanimously on the necessity of instituting examinations to detect color-blindness first among railroad employés, second among

pilots, lighthouse-keepers, and sailors in general, and third in the schools. During the Congress I had time to show the physicians the practical application of the method, by examining in their presence, by permission of Col. Carlsohn, 100 men of the artillery-regiment in Gotha, amongst whom we found 4 color-defective, 1 for red. 1 for green, and 2 incompletely blind to color. At the same time I found one green-blind among the physicians, members of the Congress, and one red-blind among the assistants.

"I was then prepared to apply directly to the railroad administration. Thanks to the press, which followed attentively the discussions in the Congress of Gothembourg, the question came to the knowledge of the public. It naturally attracted the attention of the railroad employés, who for the most part looked upon it with a certain distrust, as rather the result of learned imagination or over-solicitude, than as a practical matter for the railroad service. We have heard a railroad employé use almost literally these words: 'If color-blindness really exists, it cannot be amongst the employés, or it would have been noticed. This must at least be the case with the engineers and conductors, all of whom obtain their places after passing through inferior grades, and consequently after having sufficiently proved their faculty of distinguishing colors.' It was therefore very important to obtain some certain data on this point. This soon arose. Mr. Jacobsson, *chef d'exploitation* of the Upsala-Gefle line, asked me to accompany him on a tour of inspection, and examine all the employés under his orders. The tour was undertaken in the fall; we left Upsala Sept. 7, and to carry out our examinations halted at all the stations, at all the guard-houses, and at every gate; in short, we stopped at every point where an employé was to be found. The examination was finished at Gefle, Sept. 8. All the force, 266 men and women, were tested. Amongst them we found 13 defective; viz., 4.8 per cent. Six were completely *green-blind*, and 7 incompletely color-blind. Their positions were, 1 chief of station, 1 engineer, 2 conductors, 1 chief of equipments, 2 men of the equipment department (one a supernumerary), 2 overseers, 2 road-guards, 1 clerk, and 1 stoker. Immediately after the examination the *chef d'exploitation* dismissed all those who were blind for *green*.

"This first expedition was interesting in many respects. It showed that the method of examination was adapted to and could be used on the railroads. It showed moreover, that there were really color-blind, in nearly every degree, employed on the Swedish roads, of which no one had had the slightest suspicion.

"In Finland Dr. L. Krohn, who was by correspondence instruct-

ed in the method and principles applied in Sweden, has already examined the personnel attached to the railroads of his country. A locomotive and car were placed at his disposition to enable him to test the employés on the whole length of the line. It was completed in twelve days. He found, among 1,200 persons tested, 60 color-blind, namely, 5 per cent. They were as follows: 4 red-blind, 25 green-blind, and 31 incompletely blind."

Professor Holmgren brought this matter before the various railroad directions in Sweden. Moreover, experiments were made in the Physiological Institute at Upsala, so that by Nov. 9, 1876, throughout Sweden, it was ordered that all the railroad employés should be tested for color-blindness by the methods there used. What Professor Holmgren has accomplished leaves no excuse for our American railroads in hesitating or refusing to thoroughly and properly test all their employés for defects of color-perception, and dismissing those who are color-blind, and providing also for the future by testing all applicants for employment.

If long before this my readers have been astonished at the facts here collected, they no doubt have also been equally disposed to question them, or at least their practical bearing. They will naturally say, "We do not hear of railroad accidents from color-blindness, and rarely of marine collisions attributable to this cause." Of this I shall again speak, but I must first here explain how it is that the color-blind get on so well, conceal their defect, and perhaps avoid accident. I shall confine my remarks to the railroad personnel and mariners. Professor Holmgren explains this so readily from his experience, that I do best to first quote from him.

He says: —

"We should imagine a color-blind railroad employé would be immediately detected, or would have at least discovered his own defect. This very natural idea has greatly tended to retard the reform we have called for. It is, however, incorrect, and does not stand the test. On the contrary, examinations showed that a large number of color-blind were employed in nearly all the positions on a railroad, without they or others being aware of their faulty color-perception. And further, a number of these, far from being convinced of their defect, even after the examination, insisted on repeating the test (even six or seven times), giving all sorts of excuses in explanation of their constant

mistakes. They all agreed in saying that they had excellent sight, never had experienced the slightest difficulty in distinguishing the signals, and though a long time in service, and in most important posts, as locomotive-engineers for instance, never had made the slightest mistake.

"Certainly we may well be astonished at this condition of things, and very naturally ask how it is possible for any one to perform the duty of engine-driver, for instance, any length of time without exposing a deficiency of vision so important for the performance of this duty. There are, so far as we know, only two explanations: one is in the peculiar visual sense of the color-blind, and the exercise of this sense in distinguishing the signals; while the other depends on the conditions under which an engine-driver ordinarily does duty.

"As to the first explanation, we must remember that every color coming from an illuminated colored surface may be more or less bright or dark, and every lantern-light, even colored, may be stronger or weaker. Hence, in a colored object or colored light, the eye does not alone take note of the color or quality of the light, but also of its *quantity* or *intensity*. When two objects or two lights appear of the same color to the eyes of a color-blind person, they may differ as respects *intensity*. This being the sole difference between these lights, it is particularly noted; and thus, often as a result of special exercise, such color-blind person may strengthen his perception so as to in a certain degree make up for his color-deficiency. He resembles somewhat the persons who, deprived of one sense, replace it to a degree, by the greater exercise of one or more of their other senses. We have already noticed this point, so very important in practice, but could not refrain from again reverting to it here. Any one who has experience from conversation with intelligent color-blind, or experimenting with Maxwell's rotating disk, will have noticed their peculiar sensitiveness to *varying intensity of light*, whilst comparing two colors, and hence can have no doubt as to how a color-blind person can so often distinguish between railroad signals, and give the colors their true names.

"Did we not know this, we should be greatly astonished to find with what facility a color-blind railroad employé can distinguish between the red and green flag, and generally call the red, green, and yellow lanterns by their right color; but it is the intensity of the light, and not the color, which governs his decision, *and this is the whole secret.* The flags and lanterns have, in fact, usually a constant difference as to intensity. The green flag is to the color-blind, as also to the normal eye, undoubtedly of the deepest or

darkest color, and the red the most brilliant. As to the lanterns, the red-blind always recognize the red light by its being darker than the green, and the yellow by its being clearer or more brilliant than the other two. The green-blind finds also, in his turn, the red more brilliant than the green, and distinguishes it by this.

"The other explanation lies in the conditions under which an engineer has to observe the signals. First of all, we must remember the great regularity with which all the details of railroad service take place. An engineer starting from a station at one end of the line knows very well in advance what stations to stop at, and which to pass. Under ordinary circumstances, he knows which light ought to be exhibited on the signal-posts above the several stations. The hand-lanterns are not as important, since their color is not so essential, being supplemented by movements. Hence it is only under exceptional conditions that accidents can happen at *stations*, from mistakes as to the color of fixed lights. There may, of course, be a number of other cases exceptional to the ordinary regularity; but we must here notice one circumstance which probably has been and still is of very great importance; namely, that the engineer is not the only one who has to watch for the signals. There is always with him the stoker, and near him a conductor, an oiler, &c., to aid him at critical moments. It must be extremely rare that all the personnel of a train are affected with color-blindness.

"Considering only practically the fact mentioned, and the explanation we have given, one might perhaps imagine that color-blindness had some scientific, but hardly any practical interest, and hence that all the talk that has been made about it in railroad employés in our country was unnecessary, because, as may be said, the color-blind have often been employed a long time in railroad service without its being noticed, and without accident or the slightest inconvenience arising; and finally, that, since they can really distinguish the signals (although this is otherwise than by color), their kind of blindness need not call for any preventive measures. It is thus that a great many persons still reason.

"We do not stop here to give the testimony of experience on this point in our country. One fact is certain; namely, that color-blindness in other countries has caused numerous and very fatal accidents. Even if this had not been definitely proved, it is none the less evident that we have no right to await another such experience before passing to words and acts, and in every way showing, that, notwithstanding the numerous circumstances which assist the color-blind in responding to the signals, danger is not

wholly avoided, and the uncertainty remains. This is readily shown. Neither the fact that the color-blind have been employed many years on the railroads without causing accident, or even without their defect being discovered, nor the circumstances we have cited in explanation of this fact, furnishes the least assurance of security.

"A typical color-blind person cannot distinguish between red and green. This is an incontestable fact, readily explained by theory, and sufficiently proved by experience. All his judgment as to the difference of colors rests, in consequence, on conjecture. If perhaps, exercise enables him, up to a certain point, to distinguish between the red and green railroad lights, this is dependent on the intensity of the light telling him the color. But there is, of course, great uncertainty in this means of reading the signals; and the man who may be right in a certain number of special cases will surely go wrong in some other. It is a principle not dependent on theory, but confirmed by our experience in examining more than two hundred color-blind; and we may extend it beyond the limits we have here kept, in other words, to the majority of cases also of *incomplete* or *partial* color-blindness.

"That the situation of the color-blind in respect to signals may be thoroughly understood, we must here add a few important words on the point. What is the intensity of light? Strictly speaking, it is nothing but the force of the impression of the light which our eye receives. This, however, is dependent on two factors: one, the quantity of light radiating from the object observed or reflected by it; the other, the strength or amount to which the eye re-acts to this, or, in other words, the sensibility of the subjected visual sense. We may readily understand that both of these factors are extremely variable under the circumstances of the engineer's service. The amount of light which comes to his eye depends naturally on the amount reflected from the colored object, or which, for example, radiates from a railroad lantern. It is very evident that this quantity may vary from many causes, such as the nature of the illuminating material and the wick, the coloring matter of the glass, its thickness, the peculiar property of the glass, &c. If a little moisture or smoke, vapor, ice, snow, &c., adheres to the glass, the lantern is less luminous. A lantern illuminates differently in clear than in foggy weather. All this may give rise to mistakes. But, on the other hand, the sensibility of the eye differs greatly under different circumstances. The nervous apparatus of the eye may, like all other parts of the system, vary in its sensitiveness. The same light is brighter to a healthy eye in repose than to an eye fatigued and weakened.

Every modification of the intensity of the light is, however, for the color-blind, *a change in color*. From this we may judge how little dependence can be placed upon a recognition of the signals which the color-blind gain from exercise.

"Hence, if we admit among a large number of color-blind an extraordinary faculty gained by the exercise of the eye with different degrees of intensity of light, we must equally deny that this is sufficient for the security of the roads, as we cannot be assured of all the lantern flames being of the same strength, all the glass of the same kind, of the same thickness, purity of color, allowing the radiation of the same quantity of light, and, finally, of the eyes of the employés being always at rest to the same degree, this being practically impossible. No person in his senses would deliberately trust his life in the hands of an engineer who could only distinguish the signals by the difference in the intensity of the light. Ask any superior official of a road if he would be willing to take charge of and run a locomotive, assuming the responsibility, when uncolored signals alone were permitted, and a feeble light meant '*danger*,' a medium one '*attention or caution*,' and a strong one '*road clear*.' If he says No, tell him that these are just the conditions under which every color-blind engineer has performed his duties. The absurdity is evident at once.

"The aid an engineer can expect from those within his reach is as little to be depended on as the intensity of the light, especially as he himself is directed to observe the signals, and is responsible for what happens. Without noticing all the possible cases when he may at the moment of danger find himself without help, it will suffice to mention but a single one; namely, when his neighbors are also color-blind like himself.

"To sum up, we may grant that a number of circumstances concur in rendering railroad accidents from color-blindness of the personnel relatively rare, even when no measures have been taken to avoid them, and experience has fortunately confirmed this opinion; but, on the other hand, it is self-evident that such accidents may happen sometimes. Here also experience testifies, and there are probably many more accidents due to this cause than those proved to have so occurred. Under these circumstances, it is the absolute duty of railroad managements and maritime authorities to look to it that no measure which can aid in avoiding the possibility of these accidents shall be neglected, and to do all in their power to guard the lines of communication in the land and on the sea against all the dangers which menace them."

Dr. Stilling says as a word of warning to those who are

testing for color-blindness, "It is a well-known fact, that color-blind persons by exercising their faculty of judgment can aid their want of sensibility, and are able to conceal their defect to a certain extent. They have learned the names of colors quite as well as normal-sighted people; and by the help of every outward sign they have acquired a certain knowledge of those pigments to the characteristic tints of which they are blind. Very often that knowledge is developed in a surprising degree. Therefore in testing one who is color-blind, we must take away the possibility of employing any of those outward characteristics which he is wont to make use of according to long experience. This is so much the more important, as most persons of this description have not the least suspicion of their imperfect power of sight; only very intelligent people understand their defect."

Very few of us who have good color-perception are aware how wholly the name of a color becomes the name of an attribute of any special object, and hence how this name may be misplaced. In testing the uneducated for color-blindness this becomes very apparent. The names of colors are often so misused as to suggest color-blindness where it does not exist. It seems hardly possible, that notwithstanding a good color-perception, the names of color are so much a matter of learning and memory. As Professor Holmgren says, "This especially applies to the color-blind, who seek in every way, and without themselves being aware of it, to supplement the chromatic sense nature has refused them. As color is an immutable quality of a number of objects, some of which are of one, some of another color, it is not very difficult to learn by heart the names of their colors. The immediate impression is not necessary for this. We may hear a blind person, even one born so, give the exact names of the colors of ordinary and well-known objects of which he has heard. For a color-blind person this is easier, because he obtains some help from his incomplete chromatic sense."

To practically test this, I thought of examining some young blind people before whom the subject had not been discussed, and who would answer to the best of their knowledge and ability. The following table contains the results obtained in seven such cases. The last, the eighth, a boy of fifteen, was not wholly blind to color, and it will be seen

how different his answers were. He was practically as blind as the other seven as to form, &c. My presence at the Perkins Institution for the Blind, where these young people were, and my questions, &c., will naturally give rise to much conversation and intercommunication among the pupils, rendering any further examination of no scientific value, since to fairly test the question there must be no preliminary teaching or special attention called to the subject.

Among these seven young people, differences in intelligence and memory were marked, and largely decided the answers given, as also the way they were given. The examination was extremely interesting, and the pupils seemed to be rather pleased at being put to the test of their knowledge and memory. The two girls answered quickly as to water, having lately heard a lecture about it. As to the sky and water, teaching had of course a direct bearing; the very way some replies were given proving they were learned by the ear, and not by the eye. Could the look of the face, or gesture, or tone, be added to these answers here simply written down in short, much more force would be given my argument. Through the ear only these answers were learned, and retained by memory. The attachment of the name of a color to an object is an attribute not learned by the eye alone. A wholly uneducated person who handles bricks, if he hears them called black, will so call them when questioned as to their color. All this has a direct bearing on the question constantly presented to us when testing for color-blindness: namely, how it is that the color-blind may deceive those not familiar with such examinations, and how they get along in spite of their chromatic defect; and also, how it is that so many, finally proved to have a true sense of color, appear by any ordinary tests either very stupid, or give rise to a suspicion of color-blindness.

	What Color is?	Boy—14.	Boy—16.	Boy—15.	Boy—10.*	Boy—13.†	Girl—19.‡	Girl—12.§	Boy—15.‖ Not wholly blind.
1	Sky, . .	Blue, . .	Blue, . .	Blue when clear, . .	Red, . . .	Don't know, .	Blue, . . .	Different colors, .	Blue.
2	Grass, . .	Green, . .	Green, . .	Green, . .	Green, . . .	Guess, green, .	Green, . . .	Green, . . .	Green.
3	Water, . .	No color,—blue,	No color, .	Ocean blue near shore, different colors, .	White, no other col.,	Don't know, .	No color, colorless,	No color, ocean is blue, . . .	No color.
4	Apple, . .	Green, . .	Yellow, . .	Don't know, .	Red, . . .	Guess red, . .	Red and white, .	Don't know, . .	Different colors and shades.
5	Cherry, . .	Different colors, —red, . .	Red, . .	Black and red,	Red, . . .	Some are green,	Red or black, .	Some are red, .	Don't know; different shades.
6	Strawberry, .	Red, . . .	Don't know, .	Don't know, .	Red, . . .	Don't know, .	Red, . . .	Red, . . .	Red.
7	Banana, . .	Don't know, no idea, . .	Yellow, . .	Don't know, .	Don't know, never had one, . .	Don't know, .	Green, uncertain, .	Don't know, . .	Never noticed.
8	Autumn leaves,	Green, kind of brown, dark, .	Different colors, red, blue, green, . .	Don't know, .	Green, white, blue, green at Thanksgiving, . . .	Green, I guess, .	Different colors,—heard they were brown, red, yell'w,	Don't know; don't remember, . .	Green in summer; different tints to brownish.
9	Spring leaves,	Green, . .	Dark, . .	Green, I believe	Answer not recorded, . . .	Don't know, .	Green, . . .	Green, . . .	Green.
10	Orange, . .	Think, red, .	Yellow, . .	Don't know, sort of yellow,	Very red, . .	Don't know, .	Yellow, red, . .	Some are red, any way, . . .	Not exactly red, orange color.
11	This house, Perkins Inst'n,	Don't know, .	Sort of white, .	Don't know, think white, .	Think it is white, ain't it? . .	Guess kind of red,	Don't know, . .	Don't know, . .	White.
12	Bricks, . .	Black, . .	Sort of light, no special, .	Don't know, .	Black, . . .	Don't remember,	Red, . . .	Think they would be sort of black,	Red.

* Color of his hair. He laughed, and said *red*.

† He felt his coat, and said "it felt green." Pants "black," quickly answered.

‡ Apron pink, dress green and white, as they were.

§ Don't remember dress or apron. Bed-spread white. Boots black.

‖ He can see colors but poorly; says "they are hard to get hold of."

Wilson says, "The majority of even color-blind persons are able to distinguish bright red from bright green, when they are *near* the eye and well illuminated; but this power of distinguishing between these colors diminishes with great rapidity when they are removed to a distance from the eye, so that a separation of a few feet, or a few yards, according to the severity of the case, abolishes all sense of distinction between red and green. As the colored day-signals on railways, especially the flags, which alone are available in some of the most pressing emergencies, soon tarnish and darken, the effect of time is to change light reds and greens into much darker shades, and thereby continually to diminish the distance (small at the best) at which the two danger-signals can be distinguished from each other by a color-blind observer."

If we turn now from the land to the sea, we shall find the dangers from color-blindness as great, or even greater. The large majority of those color-blind are so for red and green. These, however, are the colors necessarily chosen by all nations to be by law carried on the two sides of all vessels from sunset to sunrise, — the green light on the starboard side, and the red light on the port side. These are so arranged that they can only both be seen when the vessel is directly ahead, and far enough off to allow us to see both sides. These lights show us, therefore, the position and the direction of motion of a vessel. Mistaking their color will of course be most disastrous.

Dr. Romberg has classified the reports of some maritime accidents from 1859 to 1866. They number 2,408.

Want of skill, or carelessness, of the ship personnel, or the accidents which it was impossible to prevent or avoid	1,562
Error of the pilot or captain	215
Want of observation or proper interpretation of the rules of the way	537
Undetermined causes	94

Under the last three heads, in the large number of 846, there are probably some attributable to color-blindness. They all are not accidents from carelessness or want of skill, for those are included in another series.

M. Léonce Raynaud and M. Degram have demonstrated the effect of fog on the color of lights. Fog or mist makes

white lights reddish. In thick weather green lights appear white. A sailing-master meets a green light rendered pale by a thick night: in whatever amount he is color-blind, in that degree will the light appear white to him, causing most dangerous hesitation; or, even if convinced he has not a green light ahead of him, he manœuvres as if it were a *red* one. Color-blindness may therefore well be considered as one of the causes of collision at sea. This imperfection may, however, occasion the loss of a vessel in another way: I mean in the recognition of lights on the coast, &c. Dr. Feris reports three cases of such mistake from the "Annales du Sauvetage Maritime," vol. iii. 1873.

Education can do nothing towards curing congenital color-blindness; nor, in truth, can any thing else.

Color-Blindness Hereditary.

Like all other congenital defects, color-blindness is hereditary, which explains the large ratio of color-blindness individual observers have found when happening to include one or more color-blind families in their statistics. In 1845 Dr. Pliny Earle reported the color-blindness of five generations of his family, as follows. Of the first he knows nothing as to their color-blindness.

Second, of 7 brothers and 8 sisters, 3 brothers had the defect. One was Dr. Earle's grandfather.

Third generation, children of the grandfather, 3 brothers and 4 sisters: no one imperfect (*that is, by tests then used; therefore doubtful*).

Fourth generation: first family of 5 brothers and 4 sisters; 2 brothers color-blind.

Second family of 1 child (girl): normal color-perception.

Third family of 7 brothers: 4 had color-blindness.

Fifth family of 3 brothers and 7 sisters: all perfect vision.

Sixth family of 4 brothers, 5 sisters: 2 of each sex color-blind.

Seventh family of 2 brothers, 3 sisters: the 2 brothers color-blind.

Eighth family: no issue.

Ninth family of 2 sisters with normal color-perception.

Seventeen of these people of the fourth generation are mar-

ried, and have 52 children. Many of the latter are very young (1845); and, as the defective perception has hitherto been detected in but two of the families, Dr. Earle places these alone on the list for the fifth generation. In one of these families of 3 brothers and 3 sisters, one of the brothers has the defect; and in the other a male, an only child, is similarly affected. We have therefore in these 32 males, 18 color-blind. Of the 29 females 2 are color-blind.

Such methods of testing as are now only considered to be truly scientific and of value would, no doubt, have revealed varying degrees of color-blindness in other members of these families. Wartmann quotes from Cunier a remarkable example of color-blindness attaching to the females rather than to the males in a family line, and this through *five* generations. It has been frequently said that color-blindness was less frequent among females than males. This is probably incorrect, and due to the fact that such a defect is of more importance with the female sex, and therefore more carefully concealed. They have not been tested as males have; and most likely future statistics, based on true methods of testing, will reverse the now quite general impression as to their having better color-impression, and hence to be preferred where admissible, as railroad employés.

Heredity has been frequently very marked, known, and reported on. Professor Wilson even says, "No fact is better ascertained than that color-blindness clings to certain families, and is hereditary. With few exceptions, every one of the parties whose cases I have specially recorded in this paper has near relatives as color-blind as himself. It seems, indeed, a safe estimate, that every decided case of color-blindness implies the existence of another case of equal or similar severity in the person of a relative; so that the numbers I have given as representing the proportion of color-blindness in the community may be fairly doubled."

Dr. Ph. Hochecher says, "Many observers have shown color-blindness to be hereditary. I am not the only color-blind in my family. Three of my mother's brothers are so, one of my cousins, and a nephew. The same is the case with one of the students whose case I report. He is color-blind, his mother, and his mother's brother, as was also his brother now dead."

Color-Blindness acquired, or from Disease and Injury.

Besides being congenital, color-blindness may be acquired, and very frequently occurs in certain diseases of the eyes or brain, and also from injuries of the head in special.

A medicine called *santonine* causes, even in moderate doses, every thing to appear yellow and sometimes violet. There are also other medicines which disturb the chromatic power. Alcoholic poisoning causes color-blindness, a most important fact not sufficiently appreciated. Persons who are poisoned by the excessive and continued use of tobacco also become color-blind. Color-blindness without loss of perception occurs in several forms of ocular troubles which are independent of, or associated with, cerebral disease.

Another important fact is the causation of color-blindness, either temporary or permanent, by injuries, especially by injuries about the head, such as are liable to occur on railroads.

Measures now taken to avoid Danger from Color-Blindness.

Are there not any such? will here at once be asked of me. I would much like to have been able to report on the some two hundred railroads of the United States in respect to any examination of their employés as to color-blindness. It is, however, a delicate question. From what I have learned, I conclude that here and there railroad superintendents keep it in mind; and when, from accident or otherwise, suspicion is aroused in reference to an employé, the latter is tested by the superintendent with the flags or lanterns used on the road. This suffices. No medical man, and much less an expert, is called upon. I shall be only too happy to be corrected, if I am wrong in stating that the railroads of this country are not more protected from the danger of color-blindness than were the roads of Europe before the very recent successful systematic efforts on the part of those from whom I have quoted in this article.

In the merchant-marine service, I very much doubt if it is any better. I have been told by naval officers that care is taken in this respect so far as to look out that the men make no mistakes as to the port and starboard lights; but I

have not learned that any systematic scientific examination of the men is carried out by the surgeons of the navy. I believe I am right in saying this also of the army. But both army and navy surgeons are eminently qualified to learn and use the present methods of testing for color-blindness, the danger from which they can equally appreciate. Testing for color-blindness is, however, a part of the physical examination of the graduating cadets at West Point, and also the naval cadets at the academy at Annapolis.

The Danger from Color-Blindness is Great.

Of this, those who have read this article will be, I think, fully convinced. We need no better proof of the recognition of the danger than the measures so rapidly taken for the last eighteen months on some of the European roads, and which are being imitated by the others. I would refer to my reports above quoted from England, France, Holland, Denmark, Sweden, Finland, Russia, Germany, and Italy.

Our very practical people have recognized the danger from numerous colored lights or signal-flags in having gradually discarded them. Many roads already use only *red* by night or day. *Green* and *red* are, however, most generally used to signify *safety* and *danger*. From experiment and experience I agree that they are right. We cannot give up *color* for *form* by night. It is, however, possible by day. The greatness of the danger is therefore shown by the precautions so quickly adopted abroad to guard against color-blindness as soon as the frequency of it was made known, and true and ready methods of observing it promulgated. Is the danger any less great here in the United States? I believe the danger from ignorance of its existence is not small. The Chief of the Brotherhood of Locomotive Engineers told me he had not heard of color-blindness, although he had run an engine twenty years, and asked me with some feeling, whether I "thought a man was fit to run an engine who could not tell green from red."

The Massachusetts Board of Railroad Commissioners report to me (Feb. 17, 1877) that "the subject of color-blindness is one which has never come to the attention of the Board;" and they "have not known of the subject being investigated in this country."

I know of nothing published in this country on the danger of color-blindness, except one or two brief articles in "The Scientific American," and an occasional paragraph in some medical journal. So far as I know, the whole question of color-blindness and its natural danger was first publicly discussed by myself last March 7, 1877, before the Boston Society of Natural History, and previously at a scientific club, where the necessity of a color-test examination was urged. I speak of this only as showing that notwithstanding the number of very competent ophthalmic surgeons in the larger cities of the Union, the subject has failed as yet to arise for discussion through their efforts. We naturally should have looked to them for warning from the danger, especially as their daily practice renders them so familiar with color-blindness from injury or disease. The subject, I confess, forced itself on my attention.

Difficulty of Examinations in the United States.

The Government can and no doubt soon will carry out proper examinations for color-blindness, in the army and navy. General national laws can also be enacted as to the merchant-marine. They will come in time, as a matter of necessity. The difficulties with the railroads are, however, very great. Here the interests and safety of the community have to contend with ignorance, prejudice, pecuniary considerations, and incredulity born of supposed immunity from danger. These corporations have no surgeons attached to their roads, who in their interests could carry out proper examinations to both protect themselves and the community. Even when interest is awakened from acknowledged danger justly feared, railroad managers are very likely to turn to any one calling himself a medical man, and rely on his statement as to his ability to examine and pass judgment on their employés. Then, when they are satisfied from his reports that they are safe, and accident happens, color-blindness is proved in the employé before the court and jury, and at once undeserved miscredit is thrown upon the surety and usefulness of such examinations. It is therefore without hesitation that we would caution as to the choice of those to be engaged in testing railroad employés for color-blindness. The life-insurance companies of the country recognize this most

thoroughly; so much so, that examination for life-insurance is almost a speciality.

We can scarcely hope for such practical good results as were shown in Sweden, where, by the simple efforts of one scientific man, all the railroad employés of the country were in a few months tested, and laws to govern the future made and enforced. Yet exactly the same is possible in this country as there. Either the State governments, or the State railroad commissioners, can require thorough examination of all employés for color-blindness, or the railroad managers can do it themselves. It is with some natural curiosity, that the solution of the problem will be watched. In one of these ways this safeguard to travellers must come, since they will learn the danger they incur, as quickly as the railroad corporations the danger they subject them to, not to speak of possible damages recoverable after an accident due to color-blindness. Not only must railroad employés and mariners have good eyesight, but they must be proved to have normal color-perception.

Conclusions.

Certainly one in *fifty*, much more probably one in *twenty*, of the community, is color-blind in greater or less degree.

Of this defect they may even themselves be wholly unconscious.

This color-blindness may practically be regarded as *red-green* blindness or *blue-yellow* blindness. Total color-blindness also exists.

This defect is congenital. It exists in varying degrees. It is largely hereditary. It may also be temporarily or permanently caused by disease or injury.

It is incurable when congenital. Exercising the eyes with colors, and the ears with their names, helps the color-blind to supplement their eyes, but does not change or increase their color-perception.

Experiment and experience show that we are *forced* to use *red* and *green* marine lights, to designate a vessel's direction of motion and movements, and at least *red* lights on railways to designate danger.

Form instead of color cannot be used for these purposes.

There are many peculiar conditions under which railroad

employés and mariners perform their duty, which render colored signals, and especially colored lights, difficult to be correctly seen.

These signals can never be correctly seen by the color-blind.

There is, therefore, great danger from color-blindness.

Railway and marine accidents have occurred from it.

There is no protection but the elimination, from the personnel of railways and vessels, of all persons whose position requires perfect color-perception, and who fail to possess this. This can now be readily and speedily done.

Therefore, through a law of the Legislature, orders from State railroad commissioners, or by the rules and regulations of the railroad corporations themselves, each and every employé should be carefully tested for color-blindness, by an expert competent to detect it. All deficient should be removed from their posts of danger. Every person offering himself as an employé should be tested for color-blindness, and refused if he has it. Every employé who has had any severe illness, or who has been injured, should be tested again for color-blindness before he is allowed to resume his duties.

The same examination should be carried out amongst pilots and masters of steamers and sailing-vessels. These latter should also be especially instructed how to detect color-blindness among the personnel of their commands.

BIBLIOGRAPHY.[1]

Abercrombie. Inquiry concerning the Intellectual Powers, 1840, p. 51. — *Aubert and Foerster.* Græfe's Archiv., vol. iii. 2, p. 38. — *Aubert.* Physiologie der Netzhaut; Breslau, 1865. — *Alexander.* Græfe's Archiv., xv. 3, p. 103. — *Annuske.* Græfe's Archiv., xix. 3, p. 254.

Benedict. Der Daltonismus bei Sehnerven-atrophie; Græfe's Archiv., Bd. 10, 2, p. 185, 1864. Wien Med.-chirg. Rundschau, 1862, Dec., p. 211. — *Boys de Loury.* Aberration dans les sensations des couleurs; Lancette française, no. 151, 1843; and Bull. de thérap., vol. 25, p. 459, 1843. — *Bronner.* On Daltonism; Med. Times and Gaz., April 12, 1856. — *Boyle.* Experiments and Considerations touching Color; London, 1670. — *Buffon.* Sur les couleurs accidentelles; Mem. de l'Académie des Sciences, p. 147, 1743. — *Bourgeois.* Manuel d'optique expérimentale; Paris, 1823. — *Brewster.* Edinburgh Philos. Journal of Science, vol. 4, 1837. — *Biot.* Précis élémentaire de physique expérimentale; Paris, 1842, t. 2. — *Brücke.* Des couleurs, trad. franc. par P. Schutzenberger; Paris, 1866. — *Brenner.* Oesterr. Zeitung für prakt. Heilkunde, 1855, p. 300. — *Bezold.* Theory of Color, translated by Koelher; Boston, 1876. — *Brücke.* Ueber das Wesen der braunen Farben; Pogg. Annal., lxxiv. 461, 1848, Bd. 150, pp. 71–93, 221–247. — *Burckhardt.* Verh. der Naturf. Gesellsch. in Basel, x. 90–93. — *Becker.* Zur Lehre von der subjectiven Farbenerscheinungen; Poggendorff's Annalen, v. p. 305. — *Bow, R. H.* On Change of apparent Color by Obliquity of Vision; Proceeds. Roy. Soc. Edinb., vol. vii. p. 155–160. — *Briesewitz.* Inaug. Dissert. Greifswald, 1872. — *Blaschko.* Der Daltonismus bei Eisenbahnpersonal; Vierteljahrssch. f. gericht. med. 1874, p. 74.

Chisolm. Color-blindness from Neuritis; Ophth. Hosp. Rep., vol. vi. 214, 1865. — *Clemens.* Farbenblindheit wahrend der Schwangerschaft; Archiv. für phys. Heilkunde, vol. xi. p. 41, 1858. — *Clemens.* Daltonisme non-congénital; Gaz. des Hôpit., p. 180, 1860; et Ann. d'Ocul., t. xliii. p. 185. — *Cornaz.* De l'hyperchromatopsie; Ann. d'Ocul., t. xxv. p. 3, 1851. — *Combe.* System of Phrenology; Edinb., 1830. — *Cunier.* Achromatopsie héréditaire depuis cinq generations; Ann. d'Ocul., t. i. pp. 417 et 488, 1838. — *Cornaz.* Quelques observations d'abnormités congén. des yeux; Ann. d'Ocul., t. xxiii. pp. 42–47. — *Chevreul.* De la loi du contraste simultané des couleurs; Paris, 1839. — *Chevreul.* Remarques

[1] This does not include, except incidentally, vision in general, or simply form perception. The large works on physiology, physiological optics, and ophthalmic surgery are omitted. The individual titles of an author's articles are not always given, but their place of publication follows his name.

sur les harmonies des couleurs; Compt. rendus de l'Acad. des Sciences, t. xl. pp. 239–242, 1855. — *Challis.* Theory of Composition of Colors; Philos. Magazine, xii. p. 329. — *Clausius.* Revue des cours scientifiques, Jan. 20, 1866. — *Chevreul.* Des couleurs, etc.; Paris, 1866. — *Cutter.* Maladie oculaire de l'électricité atmosphérique; Gaz. hebd., 24, 1849. — *Crinum.* Properties of the primary Colors, etc.; London, 1830. *Chodin.* Pression oculaire sur le percep. des couleurs; Ann. d'Ocul., t. lxxviii., 1877; Græfe's Archiv., xxiii. 3; Sammlung phys. Abhandl. von Professor Preyer, 1877. — *Colqhoun.* Glasg. Med. Journal in Frorieps Notizen, xxiv. 305. — *Czermak.* Ueber Schopenhauer's Theorie der Farben; Wiener Akad. Sitzungsber., Bd. 62, pp. 393–341. — *Chevalier, A.* Les verres colorés employés en oculistique; Compt. rend. de l'Acad. des Scien., vol. 76, p. 177, 1873. — *Chodin.* Zur Frage von der Farbenempfindungen auf der Peripherie der Netzhaut; 1873, Petersb. Med. Bote.; then Woinow's objections and Chodin's reply, pp. 95, 183. — *Cohen.* Ueber Eisenbahnfälle und deren Verhütung, Daltonismus; Nederl. Weekbl., 1874, No. 34, p. 513. — *Clarke.* Lancet, 1872, i. p. 601.

Dalton. Memoirs of the Literary Society of Manchester; vol. v. 1798, Edinb. Jour. Sci., ix. p. 97, 1779. — *Dalton.* Eigenthumlichkeit des Sehvermögens; Frorieps Notiz., No. 737, 1845. — *Decondé.* Daltonisme dichromatique; Ann. d'Ocul., t. xx., 1848. — *D'Hombres-Firmas.* Observations d'achromatopsie; Ann. d'Ocul., t. xxiii. pp. 42 et 127, 1850; Compt. rendus, 1849, ii. — *Dor, H.* De la dyschromatopsie, Sitz. der Bern. naturforsch. Gesellsch., July 20, 1872; Lyon Med., t. xvi. p. 201, 1874; et Ann. d'Ocul., 1874, lxxi. p. 104. — *Dalembert.* Mém. de l'Acad. des Sci.; Paris, 1767. — *Dove.* Eine Methode Interferenz- und Absorptionsfarben zu mischen; Berl. Monatsber., March 11, 1857. — *Durand.* Essai de phys. philosophique; Paris, 1866. — *De Martini.* Effets produits sur la vision par la Santonine; Compt. rendus de l'Acad. des Sci., xlvii. p. 259, l. p. 544; Compt. rendus de l'Inst., t. l. p. 554, 1860. — *Dolbeau.* Atrophie de la papille, Leçons de clinique chirurgicale; Paris, 1866. — *Dobrowolsky und Dr. Gaine.* Pfluger's Archiv. f. Physiol., Bd. xii. p. 432, 1875. — *Dobrowolsky.* Græfe's Archiv., xviii. 1, pp. 53–103, Berl. Akad. Bericht., 1872, p. 119. — *Dove.* Monatsberichte der Berl. Akad. d. Wissensch., April, 1871; Poggendorf's Annal. der Physik., Bd. 143, pp. 491–495. — *Donders.* Rep. Heidelberg Ophth. Soc., 1871, p. 470; Rep. Heidelberg Ophth. Soc., 1877. Quantitative Bestimmung der Farbensinnes, besonders bei Eisenbahnbeamten. — *Degrand.* Mém. de l'Acad. d. Sci., 1858. — *Donders.* Fall von vollständiger Achromatopsie; Klein Monatsbl. f. Augenheil, 1871, p. 470.

Eichmann. Achromatopsie; Med. Zeit. des v. f. Heilkunde in Preussen, No. 47, 1853, p. 224. — *Esquirol.* Maladies mentales; Paris, t. ii. p. 26. — *Eichmann.* Fechner Centralblatt, 1854, pp. 294, 295. — *Earle, Pliny.* Am. Jour. Med. Sci., 1845, April. *Emmert, E.* — Ueber der Farben; Bern, 1872.

Favre. Reforme des employés de chemin de fer affectés de Daltonisme; Lyon, 1873. Recherches cliniques sur le Daltonisme; Lyon, 1874. Sur dyschromatopsie consecutive aux lésions traumatiques; Lyon, 1875. De

la dyschromatopsie dans ses rapports avec l'état militaire et la navigation; Lyon, 1876. Du daltonisme dans ses rapports avec la navigation; Lyon, 1877. Reforme des employés, etc.; Gazette hebdomadaire, p. 578, 1873. Le traitement du daltonisme dans les Écoles; Lyon, 1877. Resumé des Mémoires sur le daltonisme; Acad. des Sci., 1877. — *Fronmuller.* Mangelhafter Farbensinn; Memorabil., t. vii. 7, 1862. — *Forbes.* Proced. Roy. Edinb. Soc., vol. iii. p. 251. 1849. — *Fizeau and Foucault.* — Ann. de Physique et de Chimie; Paris, 1849. — *Foucault.* Compt. rend. de l'Acad. des Sci.; Paris, 1850. — *Figuier.* Année scientifique; Paris, 1865. — *Faucouneau-Dufresne.* Précis des maladies du foie, etc., p. 378, 1856. — *Fick.* Zur Theorie der Farbenblindheit; Verh. d. Physik., Med. Ges. in Würzburg, neue Folge, Bd. v. pp. 158–162. — *Feris.* Du Daltonisme dans ses rapports avec la navigation; Paris, 1876. — *Falck.* Santonin; Deutsche Klinik, 1869, Nos. 27, 28. — *Francheschi.* Santonin, 1861; Ann. d'Ocul., p. 199. — *Fick, A.* Farbenblindheit, 1875.

Galezowski. Sur les alterations, etc.; Paris, 1867. Arch. gen. de Med. Sept., 1867. Sur l'achromatopsie pathologique; Compt. rend. du Congrès ophth., Paris, 1867. Sur les amauroses syphilitiques, 1867. Du diagnostic des maladies des yeux par la chromatopsie rétinienne; Paris, 1868. Cécité par cause patholog. pour les couleurs; Ann. d'Ocul., t. lxv. p. 221, 1871. Sur la physiologie des sensations colorées de la rétine; Ann. d'Ocul., t. xlix. 1863, p. 93, Jan. Fev., 1868. — *Goubert.* De l'Achromatopsie, etc.; Paris, 1867. — *Grailich.* Beitrag zur Theorie der gemischter Farben; Wiener, Ber. t. xii. p. 783; t. xiii. p. 201. — *Grandeau et Langel.* Revue des Sciences; Paris. 1865. — *Gladstone.* On his own perception of color; Rep. British Ass., ii. p. 12, 1860. — *Guepin.* L'action de la santonine; Compt. rend. de l'Acad. des Sciences, li. p. 791, 1860. — *Gouriet.* Gaz. des Hôpit. No. 113, 1861. — *Galezowski.* Rétinité glycosurique; Ann. d'Ocul., t. xlix. p. 93. Étude ophthalmoscopique, etc.; Paris, 1866, p. 47. — *Guillemin.* Les phénomènes de la physique; Paris, 1868, p. 406. — *Goethe.* Farbenlehre, 1810. pp. 126–190. — *Giros v. Gentilly.* Theorie der Farben; Lichtenberg Magazin, i. 2, 57. — *Gall.* Anat. et Physiol. du sys. nerv., iv. 98. — *Geiger.* Ueber den Farbensinn der Urzeit und seine Entwickelung; 1871, Stuttgart. — *Guillemin.* La lumière et les couleurs; Paris, 1874. *Giovanni.* Santonin; 1868, Jour. de Chimie Med., p. 373.

Hays. Impossibility of Distinguishing Colors; Am. Jour. Med. Sci., 1840, Oct. 1858. — *Helfft.* Ueber Achromatopsie, etc.; Med. Zeit. des Ver. f. Heilk. in Preussen, No. 20, 1850. — *Helmholz.* Handbuch der phys. Optik; Leipzig, 1867; Paris, 1867. — *Herschell, J. P. W.* Remarks on Color-blindness; Proc. Roy. Soc., vol. x. p. 72, 1859. — *Hufner.* Farbenblindheit in Santoninrausche; Græfe's Archiv., xiii. 2, p. 309, 1869. — *Herschell.* Metropolit. Encyclop., Article Light, p. 507, 1828. — *Helling.* Handb. d. Augenkrankheiten; Berlin, 1821, Bd. 1, S. 1–3. — *Hirtzel's.* Zeitschr. f. Phar. No. 6, 1858. — *Happe.* Lehre von den Farben; Leipzig, 1877. — *Huddart.* Phil. Trans.; London, vol. lxvii., 1777, pp. 260–265. — *Hochecker.* Ueber angeborene Farbenblindheit; Græfe's Archiv., B. xix. 3, pp. 1–37. *Harvey.* Edinb. Phil. Trans., x. 253; Edinb. Jour. of Sci., vii. 85. — *Holmgren.* De la Cécité des Couleurs dans

ses Rapports avec les Chemins de Fer et la Marine; Stockholm, 1877. Om färgblindhetoch den Young-Helmholtzska färgtheorien; Upsala, 1871. Ueber Forster's Perimeter und die Topographie des Farbensinnes; Upsala läkare fören förhandl., vii. 2, p. 87, also vol. 10, p. 541. *Vide* also Nordist. Medic. Arkiv., 1874, Bd. 6, Nos. 24, 28. — *Hering.* Sitz. d. Wiener Akad., Bd. 69, Abth. iii. pp. 85–104, 179–218. — *Himly.* Krankh. u. Missb. d. mensch. Auges, 1843, ii. p. 468.

Jeaffreson. Color-Blindness in Diseases of the Brain and Optic Nerve; Lancet, 1872, pp. 601, 635, 670, and Ann. d'Ocul., 1873, t. lxx. p. 196, 1873. — *Janssen.* Mémoire addressé à M. le Ministre de l'Instruction publique; Cosmos, Jan. 4, 1868. — *Jackson, Hughlings.* Colored Vision; Roy. Lond. Ophth. Hosp. Rep., 1875, p. 331. — *Jones, Wharton.* Failure of Sight from Railway and other Accidents; London, 1869.

Klob. Farbenblindheit bei Mangel des Corpus callosum und Hydrocephalie; Jahrb. f. Kinderheil, Bd. iii. 3, p. 201, 1860. — *Krieger.* Ueber Licht und Farbenscheu; Deutsche Klinik, Nos. 50–52, 1850. — *Krieger.* Dyschromatopsie; Ann. d'Ocul., t. xxxiv. p. 284, 1856. — *Klug.* Farbenempfindung bei indirectem Sehen; Græfe's Archiv., xxi. 1, p. 251. — *Krukow.* Objective Color Perception on Periphery of Retina; Moscow, 1873. — *Kunkel.* Ueber die Abhängigkeit der Farbenempfindung von der Zeit; Pflugers Archiv. f. ges. Physiol., ix. p. 197. — *Knoblauch.* Santonin; Deutsche Klinik, 1854, No. 35. — *Knapp.* Color-blindness in Atrophy of Optic Nerve; Archives of Ophth. and Otol., vol. vi., Nos. 1–2, p. 198.

Laurence. — Sensibility of the Eye to Color; Phil. Mag., 1861, p. 220. — *Leber.* Anomalies de la sensation des couleurs dans les affections oculaires; Klin. Monatsbl., 1869; Græfe's Archiv., xv. 3, pp. 26–107, 1870, xvii. 2, 241. — *Leber.* Klin. Monatsbl., 1873, pp. 467–473. — *Lembert.* Cas de pseudochromie; Gaz. hebd., No. 16, 1855. — *Longet.* Traité de physiologie; Paris, 1850, t. ii. p. 97. — *Lembert.* Pseudochromie; Ann. d'Ocul., 1857, t. xxxviii. p. 275. — *Lefevre.* Action de la santonine; Compt. rend. de l'Acad. des Sci., 1859, xlviii. p. 448. — *Landolt.* Percezione dei colori alla periferia della retina; Annali di Ottalmologia, 1874, Anno. iii. Fasc. 2–3; Klin. Monatsblatt f. Augenheil, 1873, p. 376. — *Lamansky.* Ueber die Grenzer der Empfindlichkeit des Auges für Spectralfarben; Græfe's Archiv., xvii. 1, p. 123; Poggendorf's Ann., Bd. 143, p. 633. — *Liebreich.* On Defects of Vision in Painters; Macmillan's Mag., April, 1872; Nature, vol. v. pp. 404, 506; Brit. Med. Jour., i. pp. 271, 296, 318. Die Fehler des Auges bei Malern; Der Naturforscher, 1872, No. 47. — *Liegey.* Cas de Daltonisme congenital; Jour. de Méd. de Bruxelles, April, 1874, p. 327. — *Lacon, Sir Stilling.* Revue maritime, 1853. — *Landolt, E.* Procédé pour déterminer la perception des couleurs; Ann. d'oculistique, 1875, p. 74. De l'amblyopie hystérique; Arch. de phys. norm. et path., 1875, p. 628. — *Lederer, A.* Farbenblindheit und mangelhafter Farbensinn mit Rücksicht auf den Signaldienst und der Marine; Wiener med. Wochenschrift, Jan. 12, 1878. — *Landolt.* Annal. d'Ocul., 1877, 2, p. 154.

Mandelstamm. Beitrag zur Physiologie der Farben; Græfe's Archiv., xiii. 2, p. 399; Gaz. hebd., 1867, p. 399. — *Maxwell.* Experiments on

Color and Color-blindness, etc.; Edinb. Trans., 1855, xxi. pp. 275–297; Edinb. Jour., (2) i. pp. 359–360; Proceed. Edinb. Soc., iii. 299–301; Phil. Mag., (4) xiv. 40; Edinb. Jour., (2) i. 361, 362; Athen., 1856, p. 1093; Edinb. Jour., (2) iv. 335–337; Inst., 1856, p. 444; Rep. of Brit. Asso., 1856, 2, pp. 12–13; Nature, vol. iv. p. 13. — *Muncke und Gehler.* Phys. Wort., 1828, Leipzig, Bd. iv. p. 1428. — *Melloni.* Bibl. univ. de Genève, Aug. 1847. — *Moigne.* Repertoire d'optique, 1851, t. ii. et iii. — *Marché.* Des alterations de la sensibilité; Paris, 1860. — *Magnus.* Entwickelung des Farbensinnes; Leipzig, 1877. — *Meckel.* Archiv. f. Physiol., i. 188; Ann. Phil., 1822, Feb. — *Müller, J. J.* Theorie der Farben; Græfe's Archiv., xv. 2, p. 208; Poggendorf's Annal. der Physik, Bd. 139, pp. 411–593. — *Mungo Ponton.* Colors and their Relations; Quart. Jour. of Sci., x. p. 74. — *Moxon.* Xanthopsia in Jaundice; Lancet, i. 1873, p. 130. — *Mayer.* History of Young's Discovery of his Theory of Colors; Am. Jour. Sci. and Art, vol. 109 (3d ser. vol. ix. p. 251). — *Mol.* Onderzoek op Kleurblindheid; Nederl. Tijds. v. Geneeskunde, 1875, No. 7, p. 89. — *Morton.* Ein neues Chromatrop; Poggen. Ann., B. 157, p. 159.

Noel. De la chromatopseudopsie; Paris, 1857; Courier des Sciences, July 31, 1864. — *Newton.* Optics, lib. i. pars 2, prop. 3. — *Noel.* Thèse de Paris, 1839. — *Nagel.* Der Farbensinn; Berlin, 1869. — *Nicholl.* Med. Chi. Trans., vii. 477, ix. 359; Ann. of Phil., N. S. iii. 128. — *Niemetschek.* Ueber Farbenblindheit; Prag. Vierteljahrsschr., 25, Jahrg. Bd. 4, pp. 224–238.

Opel, J. J. Einige Beobachtungen ueber part. Farbenblindheit; Jahresberich. d. phys. Ver. zu Frankfort a. M., 1859–60, pp. 70–144; ibid. 1860–61, pp. 42–47; ibid. 1861–62, pp. 48. — *Oesterlin.* Handbuch d. Heilmittel, 1861, 7 Aufl.

Phipson, T. L. Action de la santonine sur la vision; Gaz. hebd., No. 13, 1859; Compt. rendus de l'Acad. des Sci., xlviii. p. 593. — *Pole.* Color-Blindness; Proceed. Roy. Soc., viii. 172–177, 1856, Phil. Magaz. (4) xiii. 282–286. — *Potton.* Recherches sur le daltonisme; Gaz. de Lyon, March, 1854; Archives d'ophthalmologie, t. i. p. 158, et t. ii. p. 137, 1854; Archiv. Gen. de Med., Nov. 1854, p. 617, et l'Union med., Apr. 8, 1854, p. 174. — *Purkinje.* Achromatopsie; Berl. Encycl. Wört. d. med. Wissensch., Bd. i. s. 259. — *Parry.* Med. Trans. Coll. Phys., London, vol. iv. p. 56, 1813. — *Prevost.* Mem. de la Soc. de phys. et d'hist. nat. de Genève, t. xii. p. 196. — *Preyer.* Die Verwandschaft der Töne und Farben; Jenaische Zeitschr. f. Med. u. Naturwiss., pp. 376–388; Pflugger's Archiv., i. pp. 229–329, 1868; Med. Centralbl., 1872, No. 8. — *Purkinje.* Berl. Encycl. Wört. d. med. Wiss., Bd. i. p. 259, 1828.

Raehlmann. Daltonismus und Young-Helmholz Theorie; Græfe's Archiv., xix. 3, pp. 88–106, 1873; xx. 1, p. 232, xx. 1, pp. 15, xxi. 2, p. 27, 1875; Ann. d'Ocul., t. lxxii. p. 60, 1874; Græfe's Archiv., xxii. 1, p. 29. — *Rose, Ed.* Wirkung des Santoninum; Virchow's Archiv., Bd. vii. 2, p. 72, xvi. 1859, p. 223; Bd. xxviii. p. 15, 1860; Bd. xxxviii. p. 30, 1863; Archiv. für path. Anat. Bd. xx. p. 225, 1860; Bd. vii. 2, p. 72; Bd. xxx. p. 442; Græfe's Archiv., vii. 2, pp. 72–108. — *Rose, Ed.* Unters. Methode Farbenkranker; Berl. klin. Wochenschr. Nov. 31, 1865; Pogg. Annal., Bd. 126, 1865. — *Rosier.* Observations sur le physique et l'hist. nat. vol., viii.

1779, p. 87. vol. xiii. — *Ruete*. Lehrb. d. Ophth. 1855, B. i. pp. 179–191. *Reade*. Experimental Outlines for a new Theory of Color. London, 1816. — *Robin et Littre*. Dict. de medicine, Paris, 1865, p. 1394. — *Ricco*. Un caso di daltonismo; Annali di Ottalmologia, Anno. v. Fasc. i. p. 59, 1876. Ueber die Farbenwahrnehmung; Græfe's Archiv., xxii. i. p. 282; also more extended in Atti della R. Academia di Scienze di Modena, 1875. *Vide* also Annali d'Ottalmologia, Anno. iv. p. 315. — *Rahmer*. Zur Casuistik spinaler Augenleiden; Inaug. Dissert., Breslau, 1873. — *Reich*. Subjective Erscheinungen bei intraoculärem Druck.; Klin. Monatsb. f. Augenheil, 1874, p. 238. — *Romberg*. Das Stakenrecht auf See; Bremen, 1870. — *Reynand*. Memoire sur l'éclairage et le balisage des côtes de France, 1864.

Rood, Ogden. Observations on a property of the retina first noticed by *Tait* in Edinb. Proceed., 1869–70, vii. pp. 605–607; Am. Jour. Med. Sci., Jan. 1877.

Schelske. Farbenblindheit; Græfe's Archiv., vii. 2, p. 104, ix. 3, p. 39, 1863 ; ibid. ix. 3, p. 49 ; ibid. xi. 1, p. 175, 1865. — *Schirmer*. Erworbene und angeborene Anomalien des Farbensinnes; Græfe's Archiv., xix. 2, p. 194; Berl. Klin. Wochenschrift, p. 55, 1873. — *Schultze, Max. G.* Selben Flech, Bonn, 1866. Ueber Staebchen und Zapfen der retina; Arch. für mikr. Anat., Bd. iii. p. 215, 1867. — *Seebeck*. Mangel an Farbensinn; Poggendorf's Annal., Bd. 42, 1837, No. 10, p. 177. — *Sommer*. Chromatopseudopsie; Græfe u. Walthe., Jour. Berlin, 1823, Bd. v. s. 19–44 ; Bd. v. 4, 1824. — *Sous*. Du daltonisme; Bordeaux, 1865, p. 19. — *Szokalski*. Essai sur les sensations des couleurs; Ann. d'Ocul., t. ii. p. 11, et t. iii. p. 1, 1839–1840: Essai; Paris, 1841. — *Scott*. Phil. Trans., London, 1778, vol. lxviii. pp. 611–615. — *Szokalski*. Empfindungen der Farben; Giessen, 1842; Ann. d'Ocul., vol. iii. 1841. — *Smith*. Cause of Color and Theory of Light; 1859, Rep. Brit. Asso.; vol. ii. p. 22. — *Stellwag von Carion*. Ophthamologie; Erlangen, Bd. ii. 1, s. 634, 1856. — *Schopenhauer*. Ueber das Sehen und die Farben; 3 Auflage, Leipzig, 1871. — *Stein*. Zur Theorie der Körperfarben; Pogg. Annal., Bd. 144, p. 260. — *Sekulic*. Ultraviolet Strahlen sind unmittelbar sichtbar; Pogg. Annal., Bd. 146, p. 157. — *Schœn*. Ueber die Grenzen der Farbenempfindungen in path. Zustand.; Klin. Monatsb. f. Augenheil, 1873, p. 171. Berl. Klin. Wochen., 29, 1874. *Vide* also Græfe's Archiv., xx. 2, p. 273. — *Sauer*. Sichtbarkeitultravioletter Strahlen. Pogg. Annal., 1873, Bd. 155, p. 602. — *Stilling, J.* Lehre von der Farbenempfindungen; Klin. Monatsb., 1873. Prüfung des Farbensinn; Cassel, 1877. — *Schrœder*. Farbige Schatten; Klin. Monatsb. f. Augenheil, 1873, p. 354. — *Schöler*. Bestimmung einer der drei Grundfarben; Græfe's Archiv., xx. 2, p. 87.

Trichinetti. Chromatopseudopsie; Ann. Univer. de Méd. No. 1, Milano, 1844. — *Tyndall, J.* Phil. Mag., (4) xi. No. 139, pp. 329–333; Silliman's Jour., (2) xxii. pp. 143–146; Arch. d. sc. phys., xxxii. 221–225; Athenæum, Jan. 29, 1853; Ann. d'Ocul., t. xxx. p. 143, 1853; Dub. Phil. Mag., May, 1856. — *Tourtal*. Chromasie des Auges; Meckels Archiv., 1830, p. 129. — *Taylor*. Scientific Memoirs; London, 1846, vol. iv. p. 185. — *Treitel, Th.* Inaug. Dissert., 1875, Königsberg.

Vernon. Congenital Myopia and Limited Color-blindness; St. Barth.

Hosp. Rep., vol. ii. p. 93. — *Vierordt, K.* Messung der Stärke des farbigen Lichtes; Tübingen, 1871. — *Valhonnesta y Vendrell.* Classification y contrasta de los colores segun el S. Chevreul; Barcelona, 1874.

Wartmann. Daltonismus; Häser's Repertorium, 1839, Bd. iv. p. 125. —*Wartmann (de Lausanne).* Daltonisme; Genève, 1844 et 1849, Archiv. gener. de Med., fevr., 1846; Archiv. d'Anat., p. 56, 1846; Bull. de Brux., 137, 1849; Institute, 1849. — *Wardrop.* Morb. Anat. Hum. Eye; London, 1818, p. 196, vol. ii. — *Weicher.* De nonnullis coloribus, etc.; Leipzig, 1857. — *Wilson.* Statistics of Color-blind Persons; Month. Jour., 1853–1854. Year-book of Facts, 1858, p. 138. Researches on Color-Blindness, 1855. — *Witcke.* Wirkung des Wurmsamens; Med. Zeit. des V. f. Heil. in Preussen, No. 7, 1852. — *Woinow.* Farbenempfindung; Græfe's Archiv., xvi. 1, 1870, p. 212; xvi. 1, p. 251; xvii. 2, p. 241; xxi. 1, p. 223; Klin. Monatsblät., Bd. ix. p. 377; Græfe's Archiv., xvii. 2, 241, 1871, xxi. 1, p. 223. Ann. d'Ocul., t. lxvii. p. 112, et lxviii. p. 169, 1872. Revue médicale russe, 1874, 1–2, et 1874, 6. — *Warlomont.* Chromatopseudopsie; Ann. d'Ocul., t. lxxiv. 1875, p. 1. — *Watson, Th.* — Lectures on Prin. and Prac. of Physic, 1862, vol. ii. p. 604. — *Whisson.* Phil. Trans., lxviii. ii. 611. — *Weber.* Ueber Farbenprüfung; Klin. Monatsbl., 1873, p. 486. — *Whitlock.* Med. Chirg. Trans, vol. vii. p. 477, vol. ix. p. 359.

Young, Th. — Phil. Trans., 1802, p. 38; Lectures on Nat. Phil., 1807.

Zimmermann. Gelb- und Grünsehen nach Santoningebrauche; Deutsche Klinik, Nov. 14, 1855.

ADDENDA.

Daae, Dr. A. Farbenblindheit und Entdeckung von Farbenblinden; Centralblatt für prak. Augenheilkunde, January, 1878.

Cohn, Dr. H. Der Simultan-Contrast zur Diagnose der Farbenblindheit; Centralblatt f. prak. Augenheil, February, March, 1878.

Ragona-Scina. Su taluni fenomeni che presentano i cristalli colorati; Racc. fis. chim. ii. 207, 1847.

Donders, F. C. Die quantitative Bestimmung des Farben-Unterscheidungsvermögens; Graefe's Archiv., Bd. xxiii. 4, 1877.

Rapport van het Gezichtsvermogen van het personeel. Staatsspoorwegen; Utrecht, 1877.

Michel, J. Die Prüfung des Sehvermögens und der Farbenblindheit beim Eisenbahnpersonal und bei den Truppen; München, 1878.

Stilling. Methoden zur Prüfung des Farbensinnes; Bericht. Ophth. Gessell., Heidelberg, 1877.

Holmgren, F. Om nagra nyare praktiska metoder att upptäcka färgblindhet; Upsala, 1878.

THE
FILTRATION OF POTABLE WATER,

BY

WM. RIPLEY NICHOLS,

PROFESSOR OF GENERAL CHEMISTRY IN THE MASSACHUSETTS INSTITUTE
OF TECHNOLOGY.

FILTRATION OF POTABLE WATER.

Introduction.

Prominent among the requirements of various commissions which have been busied in different places with the matter of water-supply, is the statement which needs no commission to establish; namely, that a good drinking-water should be free from all suspended matter, and as far as possible free from color.

Comparatively few towns can congratulate themselves on having in their possession, or even within their reach, a supply of water which shall correspond in all points to the ideal drinking-water. Often the question must be decided between an extravagant expenditure of money, and a water which is of inferior quality although not actually unwholesome. In theory, financial considerations stand behind sanitary considerations; yet in practice there is always a limit which cannot reasonably be exceeded.

It is not proposed at this time to enter into any discussion as to what may be, theoretically, the best source from which the supply of water for town or city use should if possible be taken: in actual practice it is often found necessary to choose as a source of supply a river or pond, which, although it may not have become unfit for use by reason of pollution, is of inferior quality owing to the presence of suspended particles of vegetable or mineral matter, or to excessive hardness, or to coloring matter of vegetable origin in solution. In such cases it is possible to improve the quality of water which in its natural condition is not well suited for use. It may, however, be regarded as a principle in sanitary science, that a water which is *polluted* by admixture of substances known or generally suspected to be injurious, to such an extent as to require actual *purification*, should be rejected at once as a source of domestic supply; but a water too *hard*

for use may be softened by Clark's process, which is applicable on the large scale;[1] and a water containing matter in suspension may be clarified by some process of filtration, to be preceded as a rule, in the case of running streams, by subsidence. It is the purpose of the present paper to consider, in the light of American and foreign experience, *artificial filtration* on the large scale, especially with reference to the conditions which obtain in our own State; and, on account of its intimate connection with the same subject, we shall also consider the so-called *natural filtration* method of water-supply, and the filtration of water in the household.

Before beginning upon the subject proper, attention is called to certain definitions, which to some will seem, no doubt, very elementary. There is, however, a great deal of confusion in the minds of even well-educated people, as to the use of the terms *in solution*, and *in suspension*, as referred to waters; a great deal of confusion, also, with reference to the distinction between *clear* and *colorless*, ideas which are by no means synonymous. The accurate use of the terms can probably best be made plain by illustrations. If, for instance, we put some common salt into a quantity of water, after a time the salt disappears, the ultimate particles being distributed through the water so that they are no longer distinguishable by the eye, even aided by the most powerful microscope: the salt cannot be removed by simple filtration; and, although the solution is somewhat less mobile than water, it is still transparent. This is a case of solution. Suppose instead of the salt we take a quantity of blue vitriol (sulphate of copper). The phenomena would be similar, but the blue color of the compound would show itself in the solution. If the solution were saturated, i.e., if the water had dissolved

[1] The so-called hardness of water is due in the main to the presence of compounds of lime and magnesia in solution. These compounds are generally the sulphates and bicarbonates. When the hardness is due to the bicarbonates of lime and magnesia, the water becomes softer on boiling, because the bicarbonates are decomposed into carbonic-acid gas, which escapes, and the carbonates of lime and of magnesia, which are insoluble in water. Practically the same effect as that produced by boiling may be brought about by the addition of a proper amount of milk of lime. The lime unites with the bicarbonates to form simple carbonates, which are deposited as a white powder, incidentally removing at the same time most of the suspended matter which the water originally contained, and often removing more or less coloring matter. There is no serious difficulty in applying this process on a very large scale.

as much as it could, the transparency of the liquid would be diminished on account of the depth of color: it would be easy, however, to take a very thin layer of the solution, and satisfy one's self of its transparency. Such a liquid is colored, but is also clear.

Suppose, now, we take some clay, shake it with water, and then allow it to settle. The grosser particles will subside to the bottom of the vessel, but the finer particles will remain in suspension. Very finely divided clay will refuse to settle for weeks, and sometimes even for months. In such cases the liquid appears somewhat turbid and opaque; and although the individual particles are too fine to be readily removed by ordinary filters, and too small to be distinguished as particles by the eye, still the clay has not dissolved, and the very turbidity or opacity of the liquid shows the presence of solid particles, although they are extremely minute. Such an appearance is not to be described as "being colored," although finely divided clay and other material may be suspended in a liquid which does of itself possess a distinct color. One often meets with the expression, and that too in standard works, "the water is discolored by clay," when really it is a question of a colorless water carrying particles in suspension. The water in many of our New-England streams is at seasons highly colored by vegetable extractive matter in solution, while the water may at the same time be perfectly clear and transparent. On the other hand, our pond waters are often decidedly green; but simple filtration gives a colorless water, and shows the green color to have been due to particles of green (vegetable) matter which were suspended in the liquid.

I. — Artificial Filtration on the Large Scale.

The filtration of water on the large scale has been practised in England and on the Continent of Europe for many years, and has become very general in cases where the supply is taken from streams or ponds. From statistics which were laid before the Düsseldorf meeting of the German Public Health Association (in 1876) by Engineer Grahn[1], it would seem that in Germany since 1858 there has been no town of

[1] See the Deutsche Vierteljahrsschr. für öffentl. Gesundheitspflege, ix. (1877), p. 108.

considerable size supplied with unfiltered river water, while the increase with reference to other sources of supply may be seen from the following data: —

Total Number of Inhabitants in 80 *Towns of Germany, German-Austria, and Switzerland,*

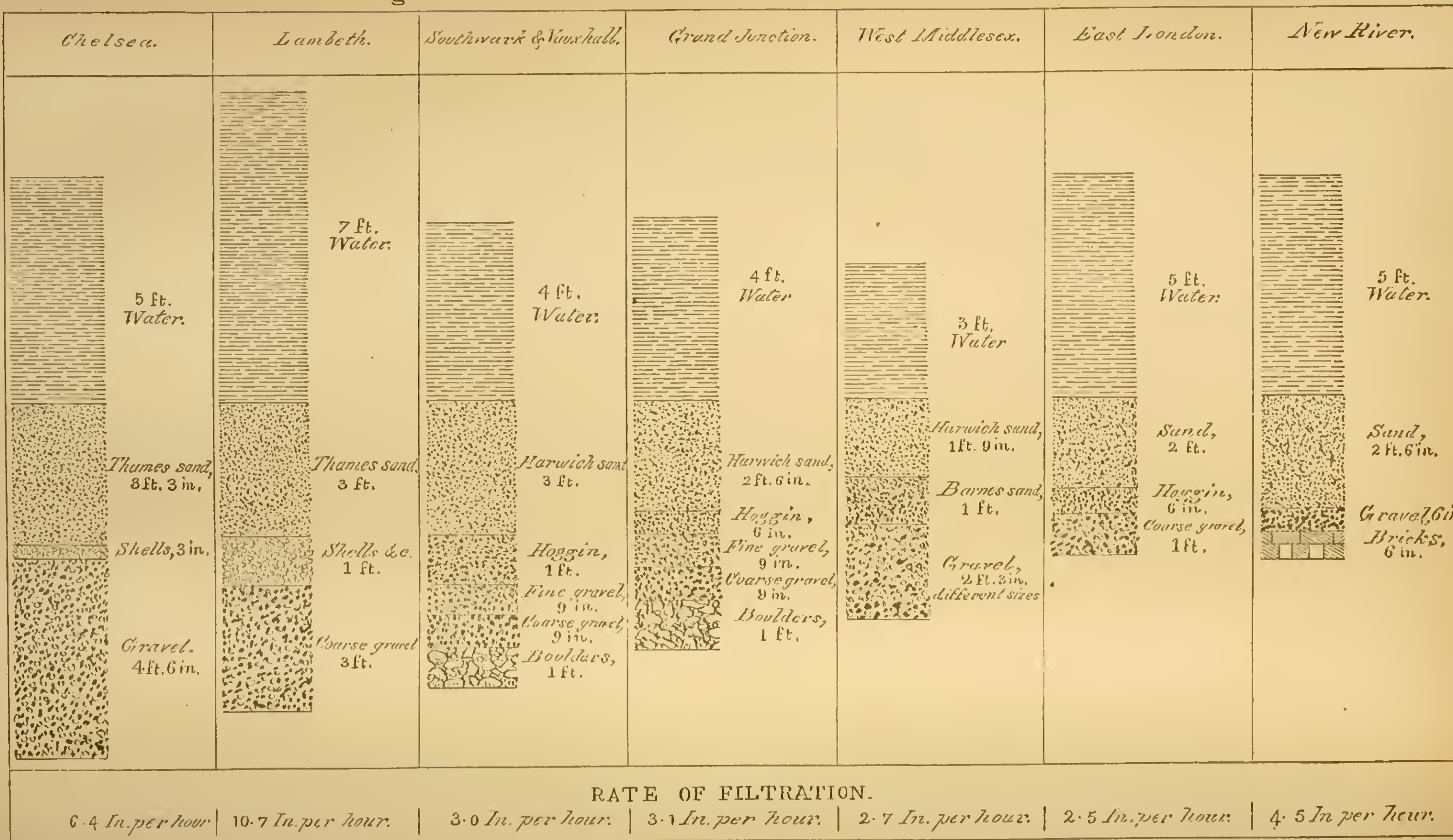
SUPPLIED WITH—	1858.	1876.
Unfiltered river water, ...	460,000	460,000
Filtered river water, ...	1,060,000	1,697,000
Spring and ground water (by gravitation), ...	25,000	1,519,000
Spring and ground water (by pumping),	45,000	1,719,000

In the United States the practice of the filtration of water on the large scale is but just beginning to come into use. In the year 1866, James P. Kirkwood, C.E., went to Europe in the interests of the city of St. Louis, to study the clarification of river waters used for the supply of cities; and his elaborate report[1] on the subject of filtration in general is almost the only book on the subject which is at all comprehensive. Full details of European practice are there given, as well as plans and suggestions for filtering-beds for St. Louis. St. Louis has not yet adopted any system of filtration, but several other cities of smaller size have done so with more or less success: namely, Poughkeepsie, N.Y., in 1871; Hudson, N.Y., in 1874; Columbus, O., in 1874; Toledo, O., in 1875. The necessity of filtration is, however, in many places felt, and would no doubt have been long since undertaken were it not for the additional outlay required for subsiding-basins and filter-beds, and the expense of maintenance.

It may be well, in the first place, to describe the general features of filtration as practised abroad and at home, to study the results obtained, and to see how far the necessity for such a process exists in our own State, and how far and under what conditions it is to be recommended. Up to the present time no filtering-material has proved practically available on the large scale, except sand, although various attempts have been made to use other substances. (See page 172.)

[1] Kirkwood. Filtration of River Waters. New York, 1869.

Fig. I.—FILTER BEDS OF THE LONDON WATER COMPANIES.



Filter-beds, as usually constructed, are water-tight basins some ten feet or more in depth, the sides built of masonry, and the bottom puddled or made of concrete, or paved with brick and cemented. The area may be from 20,000 to 50,000, or in some cases even 150,000 square feet. In building up the filtering-bed, provision is first made for the ready collection of the water by constructing upon the floor of the basin drains or channel-ways of stone or brick laid dry; then follows a layer of broken stone, the fragments being three or four inches in diameter. This is succeeded by gravel screened so as to be of uniform size, a layer of coarse being followed by one or more layers of finer material; upon the gravel rests sand likewise separated into layers of uniform size. The exact thickness of the different layers, and the extent to which the separation into the different sizes is carried, are subject, of course, to considerable variation; the accompanying cut (opp. 143) from Humber[1] will show the prevailing practice in England as represented by the various London works.

The water stands several feet deep over the surface of the sand, and is allowed to flow down through the filter at such rate as experience shows to be most advantageous. Naturally, when the sand is clean, a greater quantity of water will pass in a given time than when the sand has become clogged; practice differs as to the maximum rate; but it is seldom over six inches, vertically, per hour, and often less. At the rate mentioned, each square foot of surface would deliver 12 cubic feet (or 89¾ United-States gallons) per day.

When the beds become clogged so as no longer to filter with sufficient rapidity, the water is drawn down to from 12 to 24 inches below the upper surface of the filtering-beds, and the upper layer of sand, for a depth of one-half or three-quarters of an inch, is removed. When by successive parings the thickness of the sand has been considerably reduced, that which has been removed is washed and replaced so as to restore the original thickness, the waste of washing being made up with fresh sand. In the worst stages of the English rivers a filter-bed has to be cleaned once a week, rarely oftener. When the rivers are free from turbidity, cleansing may not be necessary more than once a month, or in some cases once in two months.

[1] Humber. Treatise on Water-Supply. London, 1877.

While it is, in general, true that the upper layer of sand does most of the work in intercepting the various floating matters in the water, it does not do the whole under the conditions which occur in ordinary practice. Examination shows that the sand is somewhat affected to a greater depth, and it may occasionally be necessary to renew all the sand. The very fact, which will appear presently, that in all actual works there are times when the water is imperfectly clarified, shows that the interior of a sand filter must become more or less fouled. The depth to which the sand becomes sensibly fouled depends upon several conditions, and mainly, in the case of any given water, upon the rate of flow, upon the *head* under which filtration takes place, and upon the frequency with which the beds are cleansed.

The *head* under which the water is filtered varies at any works according to the condition of the sand. The clear-water well is generally so arranged that the height of water in it can be lowered at pleasure; and the head under which the water is filtered is the difference between the level in the bed and in the clear-water well, as may be seen in the accompanying cut, where the head is measured by the distance between *a* and *b*. While the beds are clean, a difference of from 9 to 12 inches suffices to cause a proper rate of flow; when they become clogged a much greater pressure is required. There is a limit, however, beyond which it becomes undesirable to increase the head.

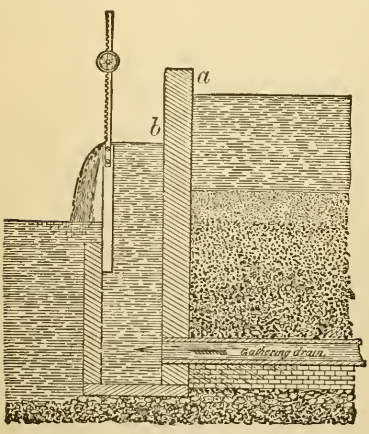


Fig. 2.

The greater the pressure, the more densely does the sand become packed; and in cleaning the beds, after scraping off the very top of the sand, the remainder is usually loosened several inches deep; but the best authorities do not advise this. The increase of pressure, too, drives the impurities to a greater depth into the sand: there is liability also, in filtering under too great a head when the bed has become somewhat clogged, especially if the water in the clear-water well is

allowed to fall below the level of the sand, that the water will force its way through the sand where the clogging material offers the least resistance, and thus pass downward irregularly and in actual streamlets.

It may perhaps be asked, why, if the work is practically done by the first few inches of sand, it is necessary to bestow such care on the construction of the beds, and on the arrangement of the materials employed.

In the first place, it is a well-recognized fact, that the worst possible filter is one in which the portions of material of different sizes are indiscriminately mixed. "The different degrees of fineness in the materials beneath the sand, and their several thicknesses, were intended first to prevent the fine sand from following the water downward into the drains, and next to insure the presence of such a body of clean water below the surface of the filter, as would penetrate the numerous joints and openings of the drains, and keep them full, without creating anywhere currents or veins of water of any perceptible difference of velocity.

"With the drains much nearer to the body of the sand, it will be understood that the tendency of the water would be to flow through the filtering-material more rapidly just over the pipe than at five feet on either side of it. The distance through which it had to travel might be so short as to induce its concentration. The low velocity at which the water flows through the filter, the uniformity of fineness in the sand, and the distance of the collecting drains from its surface, all work together to produce that regularity of action over the entire filter-bed upon which its perfection depends."[1]

While the preceding description covers essentially the greater number of existing filter-beds, there have been modifications introduced, to one of which allusion may be made. The plan adopted in some of the more recently constructed beds of the New River Company, London, is to lay bricks upon the floor of the filter-basin, end to end, with spaces between the rows. A second course of bricks laid closely together, and in the opposite direction, covers the spaces below, which thus serve as drains to carry the filtered water. Upon the upper course of bricks, is placed a thin layer of gravel, and upon this, the sand as usual. (See the cut op. page 143.)

[1] Kirkwood, page 10.

Description of American Filter-Beds.

Poughkeepsie, on the Hudson River, in the State of New York, was the first city in the Union to adopt a scheme for the artificial filtration of the entire water supply.[1] The works were constructed by Mr. J. B. G. Rand, Mr. Kirkwood himself serving as consulting engineer; and the filtering-beds are built upon the English model. The filtering-works consist[2] of a settling-basin 25 × 60 feet in plan and 12 feet deep, in three compartments, arranged with reference to the deposition of the heavier particles of mud before the water passes on to the beds. The two filter-beds are each 200 × 73½ feet in plan, and 12 feet deep, built with vertical walls: each has, therefore, 14,700 square feet of filtering-area. The six feet of filtering-materials, beginning at the top of the bed, are disposed as follows: —

24	inches	of	sand.	
6	"	"	¼ inch	gravel.
6	"	"	½ "	"
6	"	"	1 "	"
6	"	"	2 "	broken stone.
24	"	"	4 to 8 in. "	"

Total, 72 inches.

Fig. 3.
Section of Poughkeepsie Filter-Bed.

The beds have a concrete bottom or floor 12 inches in thickness, upon which are arranged open stone culverts to conduct the filtered water to the intermediate basin. The flow of water from each bed to this intermediate basin is controlled by a gate, so that while one bed is being cleaned the other may be used.

The intermediate filtered-water basin is 6 × 85 feet in plan, and 16 feet deep. This retains the filtered water until it is allowed to pass into the filtered-water reservoir. This reservoir is 28 × 88 feet in plan, and 17 feet deep; and from it the

[1] See, however, a statement on page 152 to follow.

[2] See Fourth Annual Report of the Water Commissioners of the City of Poughkeepsie, for the year ending Dec. 31, 1872.

water is pumped to the uncovered distributing reservoir from which the service-pipes are fed. Sluice-gates and drain-pipes permit the lowering of the water on the beds or in any or all of the basins.

The filtration is conducted as has been described in a previous part of this paper. When the filter becomes clogged the water is drawn down to some distance below the surface, and the top layer of sand to the depth of about one inch is carefully removed: water is again let on to the beds; and, after several cleanings have diminished the thickness of sand as much as it is thought advisable, the sand is washed and replaced.

The works at Poughkeepsie are particularly instructive, because a very careful account has been kept of the expense involved in filtering the water. The original cost of the beds was a little less than $54,000. According to figures kindly furnished me by the superintendent, Mr. The. W. Davis, the entire amount of water filtered during the year 1876 was 590,927,452 United-States gallons, and the cost of maintenance was $2,084.41. This would make the cost of filtration about $3.50 per million gallons, without including the interest on the plant ($54,000), which at 7 per cent would be $3,780.

I have also been furnished details with reference to the year 1877, during which the cost of filtering per million gallons was about $2.55. The cost of filtration thus appears smaller than in 1876: the excess of the previous year may be in part explained by the fact that an unusual quantity of sand was purchased in 1876 (namely, to an amount of $267.70 in 1876, against $72 in 1877).

As this is the only similar record of American experience which is accessible, the details are given in full as furnished by the superintendent: —

MONTH.	Cost of cleaning filter-beds.	Cost of washing sand.	Amount of water filtered, — U. S. gallons.
January,	Not cleaned,	No sand washed,	63,340,939
February,	$70 80	" "	47,637,216
March,	67 50	" "	49,886,240
April,	Not cleaned,	" "	43,868,334
May,	$35 63	$60 00	51,122,732
June,[1]	60 79	37 50	43,292,800
July,	29 50	130 00	49,112,912
August,	Not cleaned,	135 00	48,824,052
September,[2]	$129 75	125 00	45,174,068
October,	22 47	135 00	47,502,603
November,	30 75	130 00	42,298,567
December,	26 90	65 00	– –
	$474 09	$817 50	532,060,463

[1] In addition to cleaning, 2″ of sand was put on.
[2] In addition to cleaning, 4″ of sand was put on.

The expense, then, for 532,000,000 gallons, was: —

For cleaning,	$474 09
For washing sand,	817 50
For sand (60 tons),	72 00
	$1,363 59

It may be remarked in this place, that the cleaning of the filter-beds in winter is attended with considerable inconvenience. The European practice, in locations where the ice freezes to any thickness, may be learned by the following quotation from Kirkwood's account of the Berlin works: "The long and severe winters here made especial care and precaution necessary in the use of filters during the months of severe frost. The filter-beds cannot be laid bare in mid-winter; for the frost would in that case penetrate the body of the filter, and render it useless. All the filters are, in consequence, during the winter months, kept constantly covered with their maximum depth of water, — four feet. Luckily the river-water during the winter months is in its best state as regards freedom from turbidity, and also as regards freedom from vegetable discoloration or impurity. The filters, therefore, have comparatively little to intercept, and the river-water is flowed continuously upon them, and passes through them without very sensibly impairing their efficiency. To make provision, however, for an unusually

long winter, or for an exceptional condition of the river then, which may occasionally occur, it is evident that a larger filtering surface is desirable than would be necessary in a milder climate.

"The ice forms upon the filter-beds 15 inches thick, and sometimes, though rarely, 24 inches thick. To protect the enclosing walls of each filter from damage, the ice is kept separated from the walls, 6 to 12 inches, by attendants appointed to that duty; and, so long as the cake of ice is kept floating in this way, the masonry is safe from any danger by its thrust. That this service has been well performed, is demonstrated by the condition of the walls, which are in the best of order, and nowhere out of line, or abraded, that I could perceive."

At Poughkeepsie (and at Hudson, as will presently be described) the filtering-area is not sufficient to deliver the water throughout the winter without occasional cleaning. The ice has therefore to be broken up, and thrown or rather dragged out.

Description of Filtering-Works at Hudson, N.Y.

The city of Hudson, N.Y., is supplied from the Hudson River. The works were constructed, as were those of Poughkeepsie, by Mr. J. B. G. Rand. The river-water is pumped to the summit of a hill overlooking the town, on which are situated the filter-bed and the distributing reservoir. The filter-basin[1] is 13½ feet in depth, is built with sloping sides, and has an area, at the surface of the sand, of 9,081 feet.

The filtering-material is six feet deep, and is arranged precisely as in the Poughkeepsie works which have been already described. The fragments of broken stone rest upon a concrete floor six inches in thickness, having a slight inclination towards the middle or axial line, and this line towards the outlet. Along this line runs an openly-laid stone culvert 18×24 inches, which is connected by a cast-iron pipe under the division embankment with the clear-water well. From the clear-water well the filtered water passes over a gate or weir, where it is measured and its flow regulat-

[1] See Third Report of the Water Commissioners of the City of Hudson (1875).

ed, to the clear-water basin or distributing reservoir. Thence it passes ordinarily into the effluent chamber through fine copper-wire screens to the 18-inch supply pipe; but the clear-water well can be connected directly with the supply-main, so that the city may be supplied from the bed without passing the water through the basin or distributing reservoir. The distributing reservoir is 20 feet deep; its capacity is 3,200,000 gallons. The engineer who constructed the works, Mr. J. B. G. Rand, recommended that the basins be covered, and prepared plans for covering them. He says in the report alluded to, "The length and severity of the winter in this latitude on this part of the continent renders it necessary either to cover filter-beds to prevent the formation of thick coats of ice, and to enable us to reach the sand and clean it, or to have areas of sand sufficient to filter all the water required from December till April without drawing off the water for cleaning. Last winter the ice formed to the depth of 24 inches on the bed, and to a thickness of 40 inches on the clear-water basin."

He further states that "the covering would be about as useful during the warm season in checking the growth of aquatic plants, and reducing the number of cleanings at that season." I am inclined to think, that, in many places, the covering would be of *greater* advantage in the summer, but have not been able to ascertain from the superintendent or from water-takers in the town that there has ever been any complaint about the quality of the water, or that there had ever been any trouble such as has been experienced at Poughkeepsie from the growth of algæ, and which will be alluded to later (see page 165). The Hudson River contains in summer large quantities of confervoid growth, and the same sort of plants grow quite abundantly in the filtered water; but these plants, except in decay, produce no unpleasant effects.

At Hudson the sand is washed by a machine, which is rather ingeniously devised for the purpose, and is said to reduce the cost of washing considerably. The additional expense of filtering the water is considered trifling; but no separate account is kept which can give data for comparison.

Filtering-Works at Columbus, Ohio.

Columbus, Ohio, at the junction of the Scioto and Olentangy Rivers, is supplied in part with water which has been passed through an artificial sand filter similar in construction to those already described, except that the depth of sand is much less, being in fact only seven inches. The entire thickness of sand, gravel, and broken stone, is 54 inches. The basin is constructed with sloping sides, and has a filtering-surface of 8,742 square feet. The water is admitted directly to the filter-bed, but is taken from a portion of the river which, on account of a dam below, is practically a settling-basin. The usual height of water upon the sand is 30 inches, and the amount filtered when the bed is clean is about 500,000 gallons per day. The cleaning of the beds is conducted as usual; but when by successive parings the thickness of the sand has been reduced to five inches, the whole of the sand is renewed.

Filtering-Works at Toledo, Ohio.

The water of the Maumee River supplies the city of Toledo; and a single filter-bed of 20,000 feet area was for a time in use, having been constructed, or rather being ready for use, in the spring of 1875. This area proved altogether inadequate for the needs of the city, and the use of the bed was afterwards abandoned. (See page 173.)

Other American Localities.

It is not unlikely that there are other places beside those mentioned where a similar scheme of sand filtration is in use, but I have been unable to obtain details of such. The same principle is also occasionally made use of in procuring clear water for manufacturing purposes, although, as a rule, less care is exercised in the selection and sorting of the material of the bed. A very good example of such application is to be found in a paper-mill on the Agawam River near Springfield, Mass. The bed is under cover, being, in fact, in a low building with brick walls. The basin is cement-lined; and the filter is constructed by laying joists lengthwise of the building, placing slabs across, and covering with gravel, the first layer coarse, the second fine, and this covered with sev-

eral inches of sand. The sand is washed as often as the filter shows signs of clogging.

In speaking of the American localities above mentioned as being the only ones, and in speaking of there being no works established previous to 1871, I am not ignorant of the fact that a number of towns and water companies undertake to "filter" their water by passing it through broken stone, gravel, or gravel and charcoal, or even through sand and gravel. As far, however, as I have examined such arrangements, the most that can be said of them is that they act with greater or less efficiency as *strainers*, removing some of the coarser matters; the infrequency of the cleansing showing that the work done cannot be very great. This will be more evident when we consider the action of filters of sand and other material; but, to illustrate the method in which some so-called filtration is conducted in this country, I will in this place give the details furnished me in a certain instance by the superintendent of the water-works. The filter-beds were built in 1853. They are constructed with sloping sides, and measure 50 × 60 feet. The filtering-material, which consists of sand, gravel, and pebble-stones, has an entire thickness of 24 inches; and filtration is carried on under a head of from 10 to 15 feet. The beds are not used in winter, but when in use the amount of water filtered daily is 1,500,000 gallons. The beds are cleaned not oftener than once a year. This is an extreme case; but inadequate area and infrequent cleansing are the common faults of many so-called filters. Of course, occasionally, the character of the suspended matter which is to be removed is such that a very simple straining process, combined with sedimentation, is all sufficient.

I might also allude to a filter-bed which was constructed in 1876, in Lowell, Mass.[1] The bed is rectangular in plan, with a bottom area of 11,400 square feet. It has sloping sides; and the arrangement of the gathering drains and the filtering-material is substantially as in the English beds already described, except that the bottom is of pervious gravel, and below the level of the water in the river. The bed is situated directly on the bank of the river, and nearly a third of the sand surface (2,850 feet) is covered except when the river

[1] Fourth Annual Report of the Lowell Water Board, Jan. 1, 1877.

is very low; the remainder of the area (about 7,150 feet) is separated from the river by a wooden trestle-work, planked so as to form a platform, to which are fastened folding flash-board frames. In winter the frames are folded down on account of the ice; but in summer they can be raised so as to shut off the inner portion of the beds, which thus may be made accessible for cleaning. As the Merrimack carries in time of freshet a great deal of silt, which would quickly clog any filter, the outer portion of the bed would become practically useless almost at once, and the inner portion would for the same reason be useless for a considerable portion of the year. In reality the freshets of the first winter not only deposited silt on the surface of the sand, but washed in from the banks a quantity of the material which had been excavated in making the bed; and this had not been removed in the early summer when I visited the works. No doubt a considerable amount of water is obtained through the gravelly bottom of the bed by the process of natural filtration. (See page 179.)

These instances which I have mentioned show that systematic filtration as practised in Europe is not yet appreciated in this country, or that we are not yet ready to make the outlay necessary for the proper carrying-on of such a scheme.

Object and Results of Filtration on the Large Scale.

Having considered the method of filtration in common use, we may now profitably inquire more closely into the object which it aims to accomplish, and the results which are actually obtained.

Although, as we shall see later, something more is incidentally accomplished, filtration in its strict sense is simply a mechanical operation, and consists in causing a liquid containing suspended particles of solid matter to pass through some material, the pores of which, although large enough to permit the passage of liquids, are still too small for the passage of the solid particles suspended in the liquid. The suspended matter which by its presence in our water-supplies makes filtration desirable is somewhat various in character. Most rivers are liable, particularly at times of freshet, to carry a greater or smaller quantity of mineral matters in suspension; this may be, first, of such a character as to

settle quite readily by virtue of the comparatively high specific gravity of the particles, as will be the case of the mineral matter consisting of sand, mica, &c. Such material as this is readily removed by filtration; but it is generally more economical to subject the water to a process of sedimentation first, and settling-basins are quite universally regarded as a necessary preliminary to successful filtration. It is evident that without sedimentation a slower rate of filtration must be employed, and the sand must be cleaned more frequently.

The suspended matter may obstinately refuse to settle, as is the case of rivers rendered turbid by the presence of clay in suspension;[1] in which case it is almost impossible as a rule to filter the water slowly enough to obtain good results if the turbid water without previous sedimentation is put directly upon the filter-beds. Even with sedimentation the result is not always as good as might be desired. The following table, taken from the Sixth Report of the Rivers Pollution Commission (p. 215), will give an idea of the efficiency of the filtration as practised by the various London companies. The observations being made on monthly samples, the statements of the table will perhaps hardly give a just idea of the results obtained day by day; but they will serve to indicate the fact that the mere possession of filter-beds does not secure perfectly clear water at all times.[2]

[1] See, for instance, an examination of the suspended matter of the Merrimack River water in the Report of the Joint Special Committee on a Supply of Water for the City of Lowell, September, 1869, p. 76. I may also refer in this connection to the report of Professor M. B. Hardin, of the Virginia Military Institute, on the turbidity of the James River water which is supplied to the city of Richmond, Va. See the Annual Report of the Engineer for 1875. It is also stated by Mr. W. E. Cutshaw, Engineer of the Richmond Water Works, that experiments on filtering the James River water through sand have not proved successful, owing to the exceeding fineness of a portion of the matter to which the turbidity is due: he estimates that if beds were constructed they could not deliver more than twenty-five gallons to the square foot per day.

[2] These estimates of the turbidity are made by the eye alone. Recently there have been attempts to measure more exactly the amount of turbidity by means of a photometric apparatus. The general principle consists in placing a layer of the water of given thickness in front of a light of known intensity, and measuring the amount of light absorbed. See account of the Seventeenth Jahresversammlung des Vereins von Gas- und Wasserfachmännern Deutschlands, in the Journal für Gasbeleuchtung und Wasserversorgung, 1877, p. 543 and following.

TABLE I. — *Thames and Lee Water. Comparative Efficiency of different Rates of Filtration during the years* 1868 *to* 1873, *inclusive.*

NAME OF COMPANY.	Maximum rate of Filtration expressed in inches per hour.	NUMBER OF MONTHLY OCCASIONS WHEN —			
		Clear.	Slightly Turbid.	Turbid.	Very Turbid.
THAMES.					
Chelsea, ...	7.27	49	15	5	6
West Middlesex, . . .	4.71	75	0	0	0
Southwark and Vauxhall, .	6.00	41	24	5	4
Grand Junction, . . .	6.97	55	14	7	0
Lambeth, ...	12.00	42	11	12	10
LEE.					
New River, ...	5.00	70	4	0	0
East London, ...	3.85	51	18	3	2

In speaking of suspended matters it is hardly necessary to allude to fish and small animals, or to chips and sawdust and other such substances, intentionally thrown into running streams, or to leaves and other fragments of vegetable matter which have fallen from the trees and forests along their banks. Most of such floating matter can be arrested by suitable screens, which would be without effect as far as removing the finer particles is concerned.

We have spoken of the turbidity of many streams: ponds are less liable to be turbid from the causes alluded to, being, in fact, settling reservoirs; and in the case of old ponds with sandy or gravelly sides and bottom there is seldom any thing to complain of or to necessitate filtration. Ponds are, however, particularly liable to other sorts of suspended matters; namely, to growths of minute vegetable organisms. This trouble concerns so intimately the water-supplies of this region, where the water is quite commonly taken from natural or artificial ponds, that we may dwell upon it somewhat in detail.

No natural water which is exposed to the air and light, whether in pond or river, is ever entirely free from vegetable growth.

The non-professional and non-botanical observer might very likely divide the various plants found growing in the water into three classes: 1st, and most readily recognized as plants, are those commonly known as eel-grass, pond-weed, pickerel-weed, lilies, &c., which have roots and leaves, and also, at the proper season, flowers; 2d, and less readily recognized as plants, are the confervoid growths,[1] as they are often called, of filamentous structure, grass-green or in some cases bluish-green in color, forming tangled masses readily removed from the water, and, when so removed, shrinking enormously in apparent bulk, and drying away to a grayish or colorless mass, in some cases looking almost like coarse paper. Plants of this character grow in almost all reservoirs, or other bodies of water exposed to the light and air, both in still and running water: they either float in masses in the water, or grow attached more or less firmly to the rocks and stones of the bottom of the pond or reservoir. By their growth they do no harm to the water in which they flourish; and as they are readily arrested by ordinary wire screens, or easily removed by rakes or scoop-nets, their presence causes no serious inconvenience in water used for town-supply.

The third division of the non-professional would include, if indeed they were recognized as plants, those minute organisms which appear as greenish specks, or minute straight or curved threads, diffused through the water, visible enough if a large quantity of water be looked at, but perhaps almost escaping notice in the small quantity which would be taken up in a single glass. It is true that the individual plants are in some cases distinguishable by the naked eye, but their form and structure can be made out only by use of the microscope. If collected together as a scum, which often happens, especially on the windward shore of a pond, the scum is not coherent, is easily broken up, either by a wind setting in the opposite direction, by a shower of rain, or by artificial agitation. The appearance has been sometimes described as that of meal or of fine dust scattered through the

[1] These, as well as those mentioned below, belong to the class of cryptogamous (non-flowering) plants, which the botanists call *algæ*, — plants which grow in the water, or in moist places, and usually contain chlorophyll (green coloring matter), or some allied substance. To their number and variety there is almost no end.

water. The number of individuals is almost infinite, and under favorable conditions they increase with great rapidity. Their presence gives a decidedly green or greenish-yellow tinge to large bodies of water; and their death and decay often cause considerable offence to the sense of smell of those sojourning in the neighborhood, and to the sense of taste of those obliged to drink the water.

While very many species of the minute *algæ* present this general appearance, as far as my own observation and information extend, the number of species which are known to increase to such a great extent as to completely fill the waters of ponds of many acres area, and to cause sensible inconvenience, is comparatively small; the most common in this neighborhood (New England) seeming to be the *Clathrocystis æruginosa*, but certain plants réferable to the *Nostochineæ* are not uncommon alone, or in company with the *Clathrocystis*.[1]

The inconvenience caused by the presence of the plant is felt first by those who use the water for town-supply, and, secondly, by those who cut ice upon the pond. While the plant is alive and growing, there is little taste or odor given to the water, hardly noticeable if the water is iced. When the plants enter into the first stage of decay, the water acquires a peculiar taste and odor. Light and a certain degree of temperature are requisite for the normal growth of these algæ, and the decay often takes place in the mains and service-pipes: it will not unfrequently happen that the water in a reservoir or pond will have almost no taste, while the water as delivered to consumers will have a decided taste. By the settling of the green growth to the bottom in a more or less decayed state, the ponds are generally (?) cleared before the cold weather sets in; but, in several cases which have come under my observation, the material floats up to the under surface of the ice, and is frozen into the ice, making it unmarketable.

[1] It may be interesting to note, with reference to the chemical effect of the presence of these algæ, that they are highly nitrogeneous. A sample collected in the Ludlow Reservoir was dried, and was found to contain 11.18 per cent of nitrogen. The sample consisted mainly of the Clathrocystis, but of course it was impossible to separate the microscopic animal organisms from the vegetable.

Among the various questions which are often propounded with reference to the matter, are the following: —

1. What is the cause of the trouble?
2. Is it injurious to health?
3. Can any thing be done to prevent it?

1. *The Cause of the Trouble.* — Although there is no doubt that the trouble is caused by minute vegetable organisms, of whose life-history a good deal is known to botanists, various suggestions have been made as to the cause of its appearance. By many it has been supposed to be a sort of fermentation, a process of purification.[1] In some cases, this abundant appearance of the green matter has seemed to follow the apparent increase of sewage and other impurities discharged into the pond. I have within the last few years examined a great many ponds affected in this way, and cannot satisfy myself that there is any connection between such discharge of sewage and the growth of these algæ: the amount of soluble nitrogeneous matter, of ammoniacal salts, of phosphates, and of other mineral compounds necessary for their growth, are everywhere present; and it would be unsafe to prophecy the security therefrom of any pond. Although it would seem that ponds recently made by flowing marshy or cultivated land were peculiarly liable to the trouble, especially if shallow, my observations have led me to make even this statement less emphatic than I was at first inclined.

Although these plants are not all killed by a considerable degree of cold, still they *thrive* only in warm weather. Observations on this point are incomplete; but such as I have been able to collect would seem to point to a temperature of 70° F., or thereabout, below which the trouble is not likely to begin. Extended observations on this point are much needed.

I have been unable to satisfy myself that the presence of aquatic plants at the margins of the ponds has other effect than that of entangling and holding masses of scum, which if then exposed to a hot summer sun rapidly enter into decay.

[1] I have often found that residents (farmers and others) on the banks of large ponds are familiar with what they call a "fomentation" in the pond, taking place with some regularity at certain seasons of the year, which phenomenon is, in some cases at least, a growth of these minute algæ.

2. *Is the Matter Injurious to Health?*— The observations as to the effect on the human organism, of water containing these algæ, are not, of course, very definite or complete. In some places, however, where the only source of supply is thus affected, opportunity for observation is afforded. I have not been able to obtain any evidence of the unwholesomeness of the water from a supply which is in other respects of good quality. When the algæ are alive and fresh, horses and cattle drink the water readily, in preference to spring water: when decay has taken place, the water sometimes becomes so offensive that they refuse to drink it. In this condition it is manifestly unsuited for domestic use.

3. *Can Any Thing be done to prevent the Trouble?*— As far as our present knowledge extends, nothing.

Various plans of local applicability are pursued in different places, by which the annoyance is lessened. Sometimes while the vegetable matter is a scum, water may be wasted from the surface of the reservoir, at a point where the material has collected; and sometimes the pond may be left to itself, and an alternate supply made use of.

There is no difficulty in removing the vegetable matter completely by sand filtration, although of course the filters become rapidly clogged. This clogging is aided also by the development upon the beds themselves of confervoid growth, which in uncovered beds becomes so abundant and vigorous as to form a sort of carpet on the surface of the sand, which can be raked off in coherent sheets, or rolled up. If the vegetable matter in the water, or that which grows in the beds, enters into decay, and communicates an unpleasant taste to the water, the filtration may be unable to remove the taste completely.[1]

[1] I would be distinctly understood as not asserting that all bad tastes and odors to which water-supplies are subject are due to the presence of these or other algæ. They are the real cause of a real trouble. The occurrence of a *fishy*, *musty*, *cucumber*, *green corn*, or other peculiar odor or taste, may be due to the presence or decomposition of certain algæ; but it may be produced by the decay of more highly organized plants, or by causes of which we are ignorant. For instance, the cucumber taste which affected the Chestnut Hill Reservoir of the Boston Water-Works in 1875 was traceable to no such cause, nor, indeed, to any assignable cause, although careful examinations were made from a chemical, from a botanical, and from a zoölogical standpoint. Other cases also have come under my observation, where no algæ, fresh or decomposed, could be found in sufficient quantity to account for the unpleasant taste, which was very noticeable.

It also seems that filtration through sand does not remove the germs or spores of the plants; so that if the filtered water be stored in open reservoirs, exposed to light, it is again liable to vegetable growth. For this reason, such water, when once filtered, should be delivered at once into the distribution-pipes; or, if storage is necessary, it should be stored in covered reservoirs, preferably of such size as to be readily emptied and cleaned if occasion require.

We are come now to consider more particularly the action of a sand filter. On the suspended matter, the action, although simple, is twofold. In the first place, particles too large to pass into the interstices of the filter are arrested at the very outside; in the second place, and with regard to finer particles, the process is one of sedimentation and adhesion. It is well known that a turbid liquid will deposit sediment, not simply on the bottom of the vessel in which it is contained, but also upon the sides. In a sand filter, as the water passes slowly downwards, not in veins, but by percolation, the minute particles of suspended matter are attracted to and deposited upon the walls of the numerous vessels which are formed by the void spaces between the grains of sand. This is true even when the material of the filter is very coarse. If muddy water be passed *slowly* through a bed of shingle or broken stone, it will clear much more rapidly than if the subsidence takes place in an unobstructed basin.

It has already been said, that in addition to the clarification of the water, some effect is produced upon matter actually in solution. This effect has been very much exaggerated; and yet there is no doubt, that, if properly managed, sand filtration is competent to remove an appreciable amount of dissolved organic matter. The action may be explained in two ways. In the first place, most porous substances possess the power of removing certain kinds of organic matter by something which may be called *adhesion*. The absorptive power for any substance is limited and soon reached, and the substance thus removed may by appropriate means be again brought into solution. Quartz sand, as we should infer, possesses the power to a slight degree only. The second method by which dissolved organic matter is removed in the sand filter is by oxidation. The substance is actually

burned more or less completely, in part by the oxygen held in solution in the water, and in part by the air entangled in the interstices of the sand. Although in filling the beds with water, great care is taken to displace the air gradually, and as completely as possible, there must always some remain in the concavities of the individual grains of sand and otherwise entangled. The extent of the action of a sand filter in this direction depends not only on the thickness of the filtering medium, and the rate at which the filtration takes place, but also and in considerable measure upon the frequency with which the filter is cleansed. The cleansing of the filter not only removes the accumulation of organic matter, which if allowed to remain would tend to injure the water, but also involves the aëration of the sand, at least to a considerable depth.

The effect of filtration on the water of the Thames and Lee has been made the subject of experiment by the Rivers Pollution Commission and others. The following table includes some of the results obtained: —

TABLE II. — *Observations on the Water of the various London Companies.*

(From the Sixth Report of the Rivers Pollution Commission, p. 217.)

COMPANY.	Date.	Unfiltered or Filtered.	Total Solid Residue at 120°-130° C.	Organic Carbon.	Organic Nitrogen.	Ammonia.
NEW RIVER.						
New River, at Stoke Newington, .	Jan. 25, 1873, ...	Unfiltered, ...	31.98	0.350	0.084	0.004
		Filtered, ...	30.16	0.246	0.042	0
New River, at New River Head, .	Jan. 27, 1873, ...	Unfiltered, ...	31.96	0.330	0.061	0.004
		Filtered, ...	31.56	0.242	0.043	0
THAMES RIVER.						
Southwark, at Hampton, . . .	Jan. 31, 1873, ...	Unfiltered, ...	32.00	0.321	0.063	0.001
		Filtered, ...	31.56	0.273	0.042	0
Chelsea, ...	Jan. 31, 1873, ...	Unfiltered, ...	31.36	0.325	0.046	0.003
		Filtered, ...	31.10	0.258	0.032	0
Lambeth, ...	Jan. 31, 1873, ...	Unfiltered, ...	32.96	0.273	0.067	0.004
		Filtered, ...	32.74	0.258	0.038	0.001
Grand Junction, ...	Feb. 3, 1873, ...	Unfiltered, ...	31.42	0.262	0.042	0.004
		Filtered, ...	30.68	0.231	0.032	0.001
Southwark, at Battersea, . . .	Feb. 5, 1873, ...	Unfiltered, ...	31.80	0.239	0.047	0.005
		Filtered, ...	30.90	0.226	0.035	0.001
West Middlesex, ...	Feb. 7, 1873, ...	Unfiltered, ...	31.22	0.209	0.071	0.005
		Filtered, ...	30.56	0.198	0.043	0.001
RIVER LEE.						
East London, ...	Feb. 1, 1873, ...	Unfiltered, ...	34.68	0.363	0.082	0.004
		Filtered, ...	34.70	0.305	0.041	0.001

It is true that it is difficult, if not impossible, to take samples which shall represent the *same water* before and after its passage through the beds; and samples of water taken at different times of the same day, from the same locality in the river, would vary somewhat. Still, making due allowance for this fact, it is evident that in some cases there is a considerable decrease in the amount of organic matter, as indicated by the carbon and nitrogen which enter into its composition. It is also evident that sometimes this action is quite small, and that it is subject to considerable variation. As far as removing dissolved mineral matters, the action of a sand filter is practically nothing. I am aware of statements that pure quartz sand can remove saline matters, such, for instance, as common salt from salt water. I believe most of the statements rest on imperfect experiments, the results of which may be explained in other ways. I propose at another time to repeat and criticise some of these experiments. There are some, however, which seem to show that even pure quartz sand does possess to a very slight degree the power of absorbing from solution, and retaining, small quantities of mineral salts. I am convinced, however, from the latest recorded experiments on the subject, and from such as I have made myself, that, for all practical purposes, we may say that sand filtration has no effect on the dissolved mineral matter, unless there is opportunity for a chemical change to take place. Thus it seems to be well attested, that a hard water containing bicarbonate of lime may deposit carbonate of lime in the filter, owing to the escape of carbonic acid.[1] Sometimes the amount of mineral matter may be greater in the filtered than in the unfiltered water, if the material of the bed, the gravel and stones, contain, as they often do, soluble ingredients.

I have made several examinations of water from American filter-beds. The results of the examination of two sets of waters from Poughkeepsie, N.Y., are included in the accompanying table.

[1] See, for example, Lefort, Chimie Hydrologique, pp. 165, 200. It has also been shown by Schloesing (see Assainissement de la Seine, 2ième partie, Enquête, p. 191), that at some depth in soil which had been irrigated with sewage, there were formed crystals of carbonate of lime, owing to the escape of carbonic acid from the sewage-water which contained a small proportion of bicarbonate of lime in solution.

TABLE III. — *Examination of Water from Poughkeepsie, N. Y.*

[Results expressed in parts in 100,000.]

Number.	Date received.	LOCALITY.	Water as Received.		Water after Filtration through Paper.		Solid Residue.			Total Solids after filtration through paper.	Chlorine.	
			Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.			
	1877.											
408	Nov. 13,	River, . . .	0.0109	0.0197	0.0109	0.0184	10.4	1.7	12.1	10.1	0.32	Very turbid.
409	Nov. 13,	Clear-water basin,	0.0077	0.0139	0.0077	0.0139	8.9	1.1	9.1	9.0	0.30	Clear.
428	Nov. 19,	River, . . .	0.0104	0.0157	0.0104	0.0157	9.0	1.5	10.5	8.6	0.32	Very turbid.
427	Nov. 19,	Clear-water basin,	0.0112	0.0155	0.0112	0.0149	8.1	1.3	9.4	9.0	0.33	Slightly turbid.

Remarks on the Table.

In the case of the Hudson River, the river-water, besides being more or less strongly colored in the fall, is often quite turbid. A part of the matter which causes the turbidity settles somewhat readily, and a part remains suspended for a long time. I kept a specimen of the water, taken in October, for a number of weeks, without any considerable improvement in appearance after the grosser particles had once subsided. Both of the specimens of river-water submitted to examination were very turbid. The specimen numbered 409 was taken just previous to the cleansing of the filter-beds, and was filtered at the rate of about 6¾ inches per hour (i.e., about 100 gallons per square foot per hour). It was quite clear. The specimen numbered 427 was a portion of the first water pumped after the cleansing of the beds, and was slightly turbid.

In connection with the examination of the water, I may refer to the examination of several specimens of sand. A sample of washed sand (received Nov. 13), as it is put upon the beds, was found to lose on ignition 0.25 per cent. Two samples of dirty sand, as it comes from the beds, were examined, and found to lose respectively 0.74 per cent (specimen received Nov. 13), and 0.64 per cent (specimen received Nov. 14). The sand was in each case dried at 212° F. before ignition, so that the difference in the loss on ignition may be taken to represent quite closely the amount of organic matter retained. Taking the mean of these results, it would appear that every ton of sand retained mechanically about nine pounds of organic (mainly vegetable) matter. The Rivers Pollution Commission [1] found, in a case which they examined, that one ton of dry sand, washed after previous use, was capable of removing from water, and retaining, 16.1 pounds of peaty matter.

There is one matter worth mentioning in connection with the Poughkeepsie filter-beds, which strengthens the conclusion one cannot fail to arrive at in studying this subject; namely, that in our climate the filter-beds and all reservoirs used for subsequent storage of the filtered water should be *covered*. In the early summer, when the temperature of the river

[1] See the Sixth Report before alluded to, p. 215.

reaches 70° F., or a few degrees higher, the exposure of the water to the sun in a comparatively thin layer on the filter-beds causes the development of a large number of minute algæ, which by their decay in the service-pipes communicate a very disagreeable odor and taste to the water. When this growth begins, it is the practice of the superintendent to pump the greater part of the water used directly from the river into the pipes, and in this way the trouble is entirely overcome. The liability to this annoyance lasts only a short time, and it is generally only through the month of June that the beds are thrown out of use on this account. I am of the opinion that if the beds were covered, and if the water after filtration were kept in covered reservoirs, there would probably be little or no trouble from this source. It is true that there is plant-life almost everywhere, even in closed conduits and in covered reservoirs: this, however, is a different matter from the growth of algæ alluded to, and is less likely to cause annoyance. I am convinced that the best way of all is *not to store* the water after filtration, but to deliver it at once to the consumers.

I have examined also specimens of filtered and unfiltered water from the Hudson Water-Works, which were furnished me by the superintendent, Capt. John S. Ray.

TABLE IV.—*Examination of Water from Hudson, N.Y.*

[Results expressed in parts in 100,000.]

Number.	Date received.	LOCALITY.	Water as Received.		Water Filtered through Paper.		Solid Residue.			Total Solids after filtration through paper.	Chlorine.	
			Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.			
	1877.											
447	Nov. 27,	River, . . .	0.0059	0.0152	0.0059	0.0139	7.08	1.13	8.21	–	–	Turbid.
446	Nov. 27,	Filtered water, .	0.0040	0.0123	–	–	–	–	–	–	–	Slightly turbid.
464	Dec. 10,	River, . . .	0.0051	0.0152	0.0051	0.0120	7.68	0.72	8.40	–	0.30	Turbid.
463	Dec. 10,	Filtered water, .	0.0056	0.0131	0.0056	0.0123	7.12	1.02	8.14	–	0.32	Slightly turbid.
	1878.											
2	Jan. 18,	Top of filter-bed, i.e., unfiltered.	0.0123	0.0133	0.0123	0.0128	9.52	1.12	10.64	10.00	0.33	Turbid.
3	Jan. 18,	Filtered water, .	0.0237	0.0163	0.0237	0.0160	10.20	0.92	11.12	10.60	0.32	Slightly turbid.

NOTE.—In the first set of specimens, the demijohn containing No. 446 was broken in transit, and almost all the water was lost. The bed was cleaned on November 13, and on December 10.

In explanation of these results, I would say that the filtered water was sensibly clearer than the river-water, but that very little effect seems to be produced upon the matter in solution. It is exceedingly difficult, in the case of the Hudson-river water, to obtain any thing like constant results in determining the so-called "organic and volatile matter;" so that I should lay no stress upon the difference observed in this column. In the samples received in November and December, 1877, the close agreement of the "albuminoid ammonia" in the two waters, after being passed through filter-paper, shows that practically no appreciable quantity of soluble nitrogeneous organic matter was removed by the passage through the sand. The same thing was found to be true by a comparative test with permanganate of potash.

In the waters received in January, 1878, the filtered water, while less turbid than the unfiltered water, showed a positive increase in the soluble nitrogeneous matter, making it evident that for some reason the bed was not working properly.

Experiments at Springfield, Mass.

Among other experiments which I have made on the subject, I may here detail the results obtained on the water-supply of Springfield, Mass., in an experimental filter constructed under my direction. The experiment was carried on by Mr. J. C. Hancock, Superintendent of the Springfield Water-Works, who sent me, from time to time, specimens of water for analysis. The experiment was conducted in the joint interest of the Springfield Water Commissioners and of the Board of Health; and the results will appear also in the Report of the Water Commissioners of the City of Springfield, for the year 1877.

The filter was made by standing a cement-lined,[1] twenty-

[1] I should here state that I am perfectly familiar from my own experience with the objections to experiments conducted on such a small scale, owing to the tendency of the water to flow along the sides of the containing vessel, rather than uniformly through the material with which it is filled. This was in great measure obviated in the present case, by using a cement-lined pipe. I may add that there was some difficulty in regulating the flow to a sufficiently small amount, and at the same time causing it to be registered by the meter, so that the rate of flow was in several instances in excess of what would be recommended on a large scale.

four-inch main on end, and filling with material arranged as follows from the top downward:—

12	inches	fine sand.
12	"	coarse sand.
6	"	fine gravel.
6	"	medium gravel.
6	"	coarse gravel.
12	"	broken stone.
54	"	in all.

This material rested on a cement bottom six inches or so in thickness. Although the work is mainly done by the very upper portion of the sand, it was thought best, in the construction of the filter, to imitate, as far as possible, the conditions which occur in filtration of the large scale. The depth of water above the sand was about two and one-half feet, and the area of filtering-surface was about three square feet. The filter stood in a building connected with the Water Commissioners' Office, and the water was taken from the street-main by an independent pipe. The deposit in the main was occasionally purposely disturbed by the opening of a hydrant. The water began to flow on Aug. 1, and at the beginning was allowed to run slowly, afterwards more rapidly, as is evident from the readings of the meter which was attached.

DATE.	Reading of Meter.	Average rate of flow, cubic feet per hour.
August 21,	0 feet,	–
September 1,	52 "	–
" 3,	375 "	6.73
" 4,	524 "	6.20
" 5,	673 "	6.20
" 7,	943 "	5.63
" 10,	1,268 "	4.51
" 11,	1,320 "	2.17
October 4,	2,132 "	–

The filter began to clog so as to perceptibly affect the flow about Sept. 25. On Oct. 4 the flow was stopped, the water lowered in the filter, and the upper portion of sand to the

depth of an inch taken for examination. The water was then allowed to flow freely through the filter: it flowed at the rate indicated by the meter-readings as follows: —

DATE.	Reading of Meter.	Average rate of flow.
October 9,	2,133 feet,	–
" 10,	2,228 "	3.95
" 19,	3,067 "	3.88
" 24,	3,392 "	2.71
November 5 (clogged),	3,489 "	–

The results of the chemical examination of water taken before and after filtration are given in the accompanying table. In collecting specimens for examination the unfiltered water was first taken; and, after a sufficient time had elapsed for the water then flowing upon the filter to pass completely through, the filtered water was secured. Before the specimens Nos. 312 and 313 were taken, the water in the main had been disturbed, and the unfiltered water was quite turbid, and possessed of unpleasant odor and taste, which also accompanied the filtered water. Probably a better effect would have been obtained if the water had passed more slowly; but still other experiments have convinced me of the impossibility of completely removing this taste by simple filtration through sand. Before Nos. 328 and 329 were taken, the pipes were also disturbed, but the amount of sediment was then much less than before.

TABLE V. — *Examination of Water from Springfield, Mass.*

(Results expressed in parts per 100,000.)

Number.	Date.	LOCALITY.	Water as Received.					After Filtration through Paper.				
			Ammonia.	" Albuminoid Ammonia."	Solid Residue.			Ammonia.	" Albuminoid Ammonia."	Solid Residue.		
					Inorganic.	" Organic and Volatile."	Total at 212° Fahrenheit.			Inorganic.	" Organic and Volatile."	Total at 212° Fahrenheit.
304	Aug. 30,	Unfiltered, ...	0.0064	0.0261	–	–	–	0.0069	0.0235	3.08	2.40	5.48
303	Aug. 30,	Filtered, ...	0.0061	0.0235	–	–	–	0.0061	0.0189	4.12	2.88	7.00
312	Sept. 3,	Unfiltered, ...	0.0139	0.0392	4.20	2.68	6.88	0.0139	0.0323	4.04	2.20	6.24
313	Sept. 3,	Filtered, ...	0.0179	0.0275	4.52	1.92	6.44	0.0179	0.0245	4.60	1.72	6.32
319	Sept. 5,	Unfiltered, ...	0.0083	0.0229	–	–	–	0.0083	0.0227	2.72	2.60	5.32
320	Sept. 5,	Filtered, ...	0.0048	0.0248	–	–	–	0.0048	0.0235	3.40	1.84	5.24
326	Sept. 12,	Unfiltered, ...	0.0087	0.0264	3.60	2.36	5.96	0.0087	0.0264	3.48	2.36	5.84
327	Sept. 12,	Filtered, ...	0.0048	0.0219	4.00	2.44	6.44	0.0048	0.0219	3.88	2.40	6.28
328	Sept. 12,	Unfiltered, ...	0.0088	0.0459	3.40	3.32	6.72	0.0088	0.0240	2.80	2.84	5.64
329	Sept. 12,	Filtered, ...	0.0040	0.0216	3.84	2.48	6.32	0.0040	0.0216	4.08	2.16	6.24
353	Oct. 5,	Unfiltered, ...	0.0104	0.0520	4.16	2.00	6.16	0.0109	0.0403	–	–	–
354	Oct. 5,	Filtered, ...	0.0056	0.0299	4.36	1.52	5.88	0.0056	0.0299	–	–	–
Average of unfiltered water, ...			0.0094	0.0354	3.84	2.59	6.43	0.0096	0.0282	3.22	2.48	5.70
Average of filtered water, ...			0.0072	0.0249	4.18	2.09	6.27	0.0072	0.0234	4.02	2.20	6.22

The sand taken from the top of the filter, after drying at 212° F., was found to lose, when ignited, 0.91 per cent of its weight; after being washed, and brought into condition to be replaced, it lost only 0.46 per cent, showing that it had removed from the water filtered through it a considerable amount of organic matter, about the same as was found to be the case with the sand from Poughkeepsie (see page 165).

As a result of the experiment it was evident that there was no difficulty in removing completely all matter in suspension, provided the flow was not too rapid. The water after filtration was generally bright and clear. At first there was a trifling increase of the inorganic matter, due, no doubt, to the action of the water on the material of the filter. It was further evident that there was a slight decrease in the organic matter which was in a state of solution in the water, as may be seen by comparing the amounts of "albuminoid ammonia" obtained from the respective waters after filtration through paper. This "albuminoid ammonia" may be taken as an index of the relative amounts of nitrogeneous matter.

Other Substances beside Sand.

Many other substances have been proposed from time to time as suitable to replace the sand wholly or in part, and to accomplish more than sand can in the chemical action on the impurities of the water filtered. The only one, however, which has met with practical success on any thing like a large scale, is the so-called carbide of iron, of Mr. Thomas Spencer, which is used by several towns in England. The carbide of iron is prepared by roasting a mixture of hematite iron-ore and sawdust, and is no doubt very efficient as a purifying agent. It is, however, expensive, and could hardly be prepared for less than $20 or $25 per ton, and for the best effect should be preceded by a rough sand filtration. At Wakefield, England, where, to be sure, the water is extremely filthy, and the bed confessedly overworked, the Rivers Pollution Commission found that "the water, owing in part to putrescent fermentation and subsidence, and in part to filtration, was chemically less contaminated than might be expected, yet on both occasions it contained a large proportion of nitrogeneous organic matter. It was of a greenish-yellow color, and on one occasion very turbid."

Wood-charcoal is often used in filters of small size, mixed with sand. Practically, however, it adds nothing to the efficiency of a properly managed sand filter. One way in which charcoal is used is illustrated by the works of Marshalltown, Iowa. Here a filter-basin, 32×16 feet, was built of masonry; and a filter-floor of two-inch plank was supported on joists laid crosswise. The floor was pierced with three-fourth-inch holes, and covered with wire gauze. On this there is a layer of charcoal four inches thick, and above this 14 inches of clean gravel and sand.

I am informed of a method of filtration in use by the Water-Works Company of Clinton, Iowa, where a number of boxes, 16 in fact, filled with charcoal, gravel, and sharp sand, rest upon the conduit. The water flows on to the boxes, and through the material into the conduit. The boxes can be raised one at a time for cleaning. In case of fire, however, the water is taken into the conduit without filtration.

I should perhaps also allude to a system of filtration devised by Mr. J. D. Cook, chief engineer of the Toledo Water-Works. This consists of a series of settling and filter chambers, the filtration being upward through sand, gravel, and charcoal: any one of the chambers can be cleaned independently of the others. It is stated that an experimental filter tested with the turbid water of the Maumee River gave excellent results: the filter has not, however, as yet been put into actual operation on a scale sufficient to judge decisively as to its availability for use in supplying a town of considerable size.

Conclusions.

I will here bring together the general conclusions reached from a study of the practice and results at home and abroad, and from my own experiments.

1. No material has yet been brought into practical use for artificial filtration on the large scale, except sand.

2. With our present knowledge we have no evidence that sand filtration can be regarded as an efficient means of purification of *polluted* water; although it may, if properly carried out, lessen the liability of ill effects.

[1] See Annual Report of the Toledo Water-Works, for the year ending Jan. 1, 1877.

3. All visible suspended particles, and an appreciable proportion of organic matter actually in solution, may be removed by properly conducted filtration through sand.

4. For the present, at any rate, it will be best to regard artificial filtration mainly as a means for the removal of *suspended* matters, although under the management of a person of intelligence, education, and experience, the simple sand filter is capable of producing sensible improvement in respect to the organic matter which is dissolved in the water. In ordinary practice, however, it is quite certain that sufficient care will not be taken to secure such results; and, in view of what is actually accomplished in existing works, it seems to be best to regard the removal of color and unpleasant taste as incidental, and likely to vary very much according to the condition of the filter.

As the public mind becomes educated in the matter, a higher standard of efficiency may be exacted; but for the present it should not be held out to towns and water-boards as a result which will follow filtration through sand, that a water which is naturally strongly colored by vegetable extractive matter will be rendered colorless in ordinary practice, although it is true, that, starting with an entirely new filter, the first portions of water filtered may be deprived of color, and such an experiment has often led into error.

5. It not worth while to introduce a system of sand filtration in the case of any town-supply unless there is the willingness to make such outlay for construction and maintenance as shall render the scheme thorough and efficient. This will involve properly constructed filter-beds and generally settling-basins of sufficient size; it will involve intelligent supervision, and frequent cleansing and renewing of the material of the filter. It should also involve, in the construction, the covering of the filter-beds; and for the best effect the filtered water should be delivered at once to the consumers. There should be at least duplicate beds, so that there can always be one in use. If on account of lack of duplicate beds, or for other reasons, it seems necessary to store the filtered water, this should be done in covered reservoirs of small size, which can be readily emptied and cleaned if occasion require. It cannot be said too emphatically, that sand filters, or indeed filters of any description, are not auto-

matic, and that the effect obtained depends not only on the construction of the filters, but also, and even more, upon the care with which they are managed. I believe that money expended on a scheme for filtration is practically wasted unless a sufficient outlay is made to secure certain efficiency. It is possible to store the filtered water under such conditions that it shall become as bad as before filtration. A desire for economy in original outlay may lead to a scanty area of settling-basins and filter-beds; but a subsequent larger demand than the plant can meet will necessitate either too rapid filtration, by which imperfectly filtered water will be obtained, and the beds fouled throughout; or an admixture of unfiltered water, which, even if necessary for a short time only, will foul the pipes, and undo the subsequent work of the filter.

I should not recommend any town to undertake the artificial filtration of their water unless they were willing to face the probability of its costing from $2.50 to $3.00 per million gallons in addition to the original outlay for the works.

II.—Natural Filtration.

The so-called *natural filtration* has already been described to a certain extent in the Fifth Annual Report of the State Board of Health in connection with the water-supplies of Lowell and Waltham. As, however, each year witnesses an increase of the number of towns thus supplied, and as it is important that the principles on which the process depends should be clearly understood, it will be appropriate to briefly discuss the matter in connection with the artificial filtration which has just been considered.

In the first place, it is necessary to obtain some clear idea of what is meant by the "ground-water;" for this is the source of the water obtained by this method. Most rivers of any size flow for a portion of their course through beds of sand and gravel of greater or less extent, which have been deposited by the river itself at an earlier stage of its history. Many ponds and lakes are situated in a similar deposit. In any such case, near the banks of the river or pond, the water stands in the gravel at approximately the level of the river or pond; and, as we recede from the banks, the water-level is found to rise more or less regularly according to the character of the deposit. In fact, in any deposit of sand or gravel

resting on an impervious stratum of rock or clay, water will usually be found. This is often spoken of as the ground-water, or by engineers as the water-table.[1] Although subject to fluctuation, the ground-water often maintains a very uniform relative level over large areas: its height and fluctuations are important factors in the sanitary condition of any locality.

The water obtained by sinking a well into a stratum of sand or gravel which has not been artificially disturbed is, as a rule, bright and clear, and free, or nearly free, from organic matter. Although originally coming from the atmosphere, in its slow passage into and through the ground the water has been subjected to a long process of sedimentation and filtration, combined with processes of oxidation. In this sense, the water may be said to have been purified by *natural* filtration: the process, however, is not brought about by the means taken to collect and utilize the water, but has been practically completed before the demand is made upon it.

We will consider first the principal methods by which this underground supply is made available, and then discuss its proximate source and the effect of such taking upon the ground-water itself.

The most simple method, and the one earliest adopted, is to sink a well, covered or open, into the water-bearing stratum, and to pump therefrom. Such a well, which draws its supply from the ground-water proper, is generally called a shallow well, in distinction from a deep well, which may extend into a rocky stratum, and obtain its supply from a water-bearing fissure; and in distinction also from an artesian well sunk to a considerable depth into underlying strata which have no connection with the ground-water of the particular locality. This method of shallow wells has been employed from time immemorial on the small scale requisite for supplying the water for a single family or group of families: it has also been and is frequently used in supplying a portion or the whole of the amount needed by large communities. A good and accessible example of such a well is that situated in Prospect Park, Brooklyn, N.Y., which

[1] Or as the water-spring or water-basin. The water-table might more strictly designate the surface of the ground-water, but there is no consistency in the use of the term.

is some thirty-five feet in diameter, and supplies 700,000 gallons daily. The water, although suitable, is not used for domestic supply.

Attleborough, Mass., is supplied by a similar well, although in this case a portion of the water is derived from a lower stratum by means of iron pipes driven into the bottom of the well, and the well itself is dug in a gravelly intervale, about seventy-five feet from the river. This method of procuring a supply of water is also quite common in the Western States. Many industrial establishments, especially bleacheries and paper-mills, are supplied with water in this way, the wells being generally located near the banks of a stream.[1]

In some places the well from its dimensions may more properly be called a basin, and this form of construction is of long standing abroad. The works of some of the towns and cities in Europe where such basins are in use are described by Kirkwood; and for details of others reference may be made to the books, the title of which appear at the end of this article. In our own country the pioneer basins are said to be those of Newark, N.J., which were constructed in 1869. There are now many others in the United States, and several in Canada. In Massachusetts the cities of Newton and Taunton are supplied from uncovered basins on the banks of rivers. The town of Waltham is provided with a filter-basin

[1] In order to obtain some definite idea of the extent to which the various methods of filtration were employed in furnishing water for manufacturing purposes in this State, the Secretary of the Board addressed a circular to various manufacturers of the finer grades of paper, the names being obtained from a trade directory. Fifty-one circulars were sent, and twenty-seven replies received. The circular was as follows : —

COMMONWEALTH OF MASSACHUSETTS.

OFFICE OF STATE BOARD OF HEALTH.

STATE HOUSE, BOSTON, Sept. 1, 1877.

DEAR SIR, — It is expected that the next Annual Report of the State Board of Health will contain a paper by Professor Nichols, of the Massachusetts Institute of Technology, on the subject of filtration of water both on the large and on a household scale.

Although the subject will be considered primarily from a sanitary point of view, it is desired not to neglect the question of the filtration of water for industrial purposes. We are aware of the necessity of clear and colorless water in the manufacture of the better grades of paper, and are also acquainted with some of the many devices which have been adopted for obtaining water suitable for this use. In order, however, that we may make the matter more

of somewhat similar construction, to which more particular allusion will be made hereafter.

The second method of collecting the ground-water is by means of a covered gallery or tunnel constructed in part of porous material; often the top and sides are built of tolerably impervious masonry or brickwork, while the bottom is of an open character, so that the water which rises into the gallery shall come mainly from beneath. An example of this now quite common mode of collection is at Lowell, Mass. A description of the works was given in the Fifth Annual Report of the Board of Health. The "filtering-gallery" is situated about 1,500 feet above Pawtucket Bridge, on the northerly shore of the Merrimack River and parallel with it, about 100 feet from the water's edge. Its length is 1,300 feet, width 8 feet, and height (inside) 8 feet. The side-walls have an average thickness of 2¾ feet and a height of 5 feet, and are constructed of heavy rubble-masonry, laid water-tight in hydraulic mortar. The walls support a semicircular brick arch, one foot thick, made water-tight. Along the bottom, stone braces, one foot square and eight feet long, are placed, ten feet from centre to centre, between the walls, to

complete, by having data from the experience in our own State, we should esteem it a favor if you would be willing to answer the enclosed questions.

Please address replies, as early as you may find it convenient, to Professor Nichols.

In behalf of the State Board of Health,

Very respectfully yours,

CHARLES F. FOLSOM, M.D., *Secretary.*

1. Name of mill.
2. Owners.
3. Location,—town? On what stream?
4. Source from which water is taken for manufacturing purposes.
5. If the water is subject to any process of purification, please indicate the process, and the results obtained.
6. If the process be one of *filtration*, please indicate—

(*a*) The material employed; or the maker of the filter, if a patented filter is employed.

(*b*) The amount of water filtered daily.

The number of replies was too small to furnish data from which to make accurate particular statements. The general facts ascertained are as follows: The greater number of the mills from which replies were obtained either use spring, river, or pond water as drawn, or else, and more often, subject it to simple straining through wire screens, excelsior, flannel, &c., or pass it through sponge filters. Of the rest, a few have some such systematic arrangements for artificial filtration as have already been described on page 151, but a larger number rely upon shallow wells sunk near the banks of a running stream.

keep them in position. The bottom is covered with coarse-screened gravel, one foot thick, to the level of the brace-stones.[1]

This description will be made somewhat clearer by the accompanying cut, taken by permission from Fanning's "Water Supply Engineering."

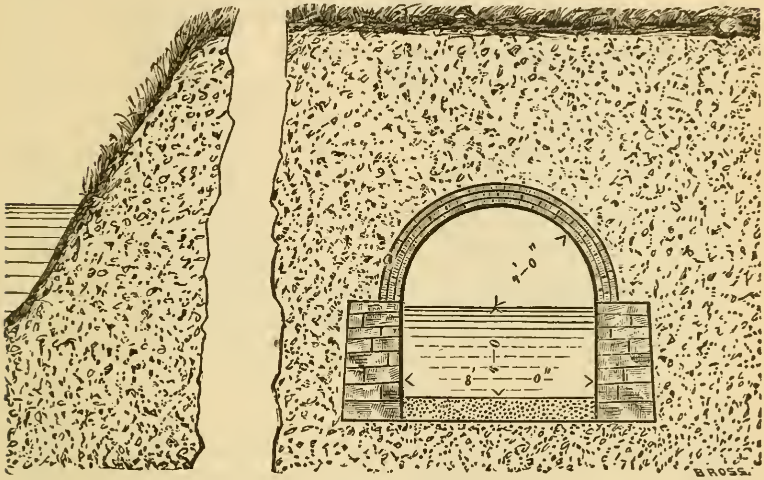


FIG. 4.
Filter-gallery, Lowell, Mass.

It may be remarked that the quantity of water which can be obtained has proved inadequate to the wants of the city, and some water is taken directly from the river. The bottom area of the gallery has more recently been increased by the construction of what purports to be a filter-bed, as already described on page 153.

A third method, which as far as I know has not been employed in this country, is to substitute for the collecting-gallery a line of iron pipes, i.e., practically water-mains, cast with a great number of narrow longitudinal slits, and laid with loose joints. These pipes collect the water, and conduct it to receiving-wells from which the supply is pumped. In filling the trench in which the pipes are laid, the pipes are surrounded on all sides with coarse material, of too large a size to fall into or through the slits, and the trench is then filled with screened material of decreasing size. Works of

[1] Third Annual Report of the Water Commissioners of the City of Lowell, January, 1873.

this character are in operation in various places in Germany, as for instance in Dresden and in Halle. Full details may be found in the reports of these cities, the titles of which are given farther on. The figure No. 5 will give some idea of this method. A somewhat similar method, in use in this country and abroad, consists in substituting for the iron pipes ordinary cement or other unglazed drain-pipes laid loosely. At Arlington, Mass., such an arrangement is in operation, the pipes being laid in the gravelly bed of an artificial reservoir made by damming a small brook.

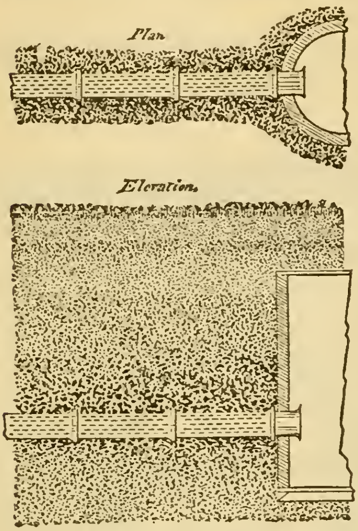


Fig. 5.

Sometimes the collecting-galleries or pipes are, as in the instance just mentioned, placed actually beneath the bed of a river or pond. The following is a description of the filtering-gallery in use, with very satisfactory results, at a paper-mill on the Westfield River, the details of which were furnished me by one of the proprietors, C. O. Chapin, Esq.: —

"The water used for washing and cleansing purposes is obtained from a gravel or sand bed or bar about 1,200 feet up the stream from the mill, and on the opposite side. This bar lies within the bed of the river when the water is high, although not covered with water for the greater part of the year. In this gravel-bed, a trench of 250 feet long was dug, of such depth as to bring the bottom of it as low as, or lower than, the bottom of the river at its deepest part, and of six feet or more in width. The trench was then filled to the depth of a foot with stones of various sizes, from small cobble to coarsest gravel stones, making the surface as even as possible, though with a slight grade down stream.

"On this foundation a line of timbers six by six inches is laid on each side of the trench, four feet apart. Across these are placed and firmly nailed on, three feet apart, square frames four feet wide by three feet high, made of timber six by six inches, each frame strengthened in the centre by a standard two and one-half by

six inches from the top to the bottom. The top and two sides of this row of frames are covered with hemlock plank two and one-half inches thick; and thus a filtering-gallery 250 feet long, three

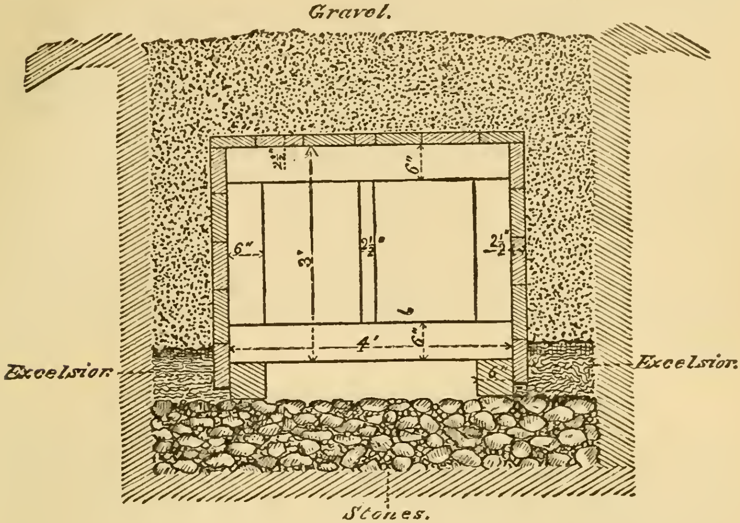


FIG. 6.

feet high, and four feet wide, is made. On the outside of this gallery, at the bottom, a filling of eight inches of excelsior is lightly tramped down; and then the trench is filled up with the gravel, and the filter is complete. From this filter 600 gallons per minute of the clearest water are obtained. The filtration is upward and through the stone bottom: the gallery is kept full in low water by taking water through canals over the filter from a point in the river above."

The account of this gallery has been given with some detail, to show that at a comparatively small expense it might often be possible for a village or small town to procure a supply of water of superior quality, although some modifications might be suggested if the water were to be used for domestic purposes. The possibility in any given case, of obtaining conditions sufficiently favorable for the adoption of such a scheme, would be necessarily a matter of experiment. The town of Decatur, Ill., is actually supplied by a similar gallery, which is thus described by the superintendent: "We filter by a natural process by sinking a crib measuring 10 feet × 110 feet, and 50 feet from and parallel with the river, into a stratum of gravel, the bottom of crib being

about three feet below bed of river, and seven feet below low-water mark. The crib is not large enough, and we are going to enlarge it next season." It is not perfectly clear, from this description, whether the "crib" is covered over or not.

I may say at this point that open basins for the collection of ground-water are liable in summer to vegetable growth. This, as far as my own observation extends, is always of a confervoid character (*Spirogyra*, *Œdogonium*, *Zygnema*, &c.), and does not give any serious trouble. There are cases, however, on record, where there has been so much trouble on this account as to make the covering of the basin necessary.[1] It depends somewhat, no doubt, upon the character of the water.

Character and Proximate Source of the Water.

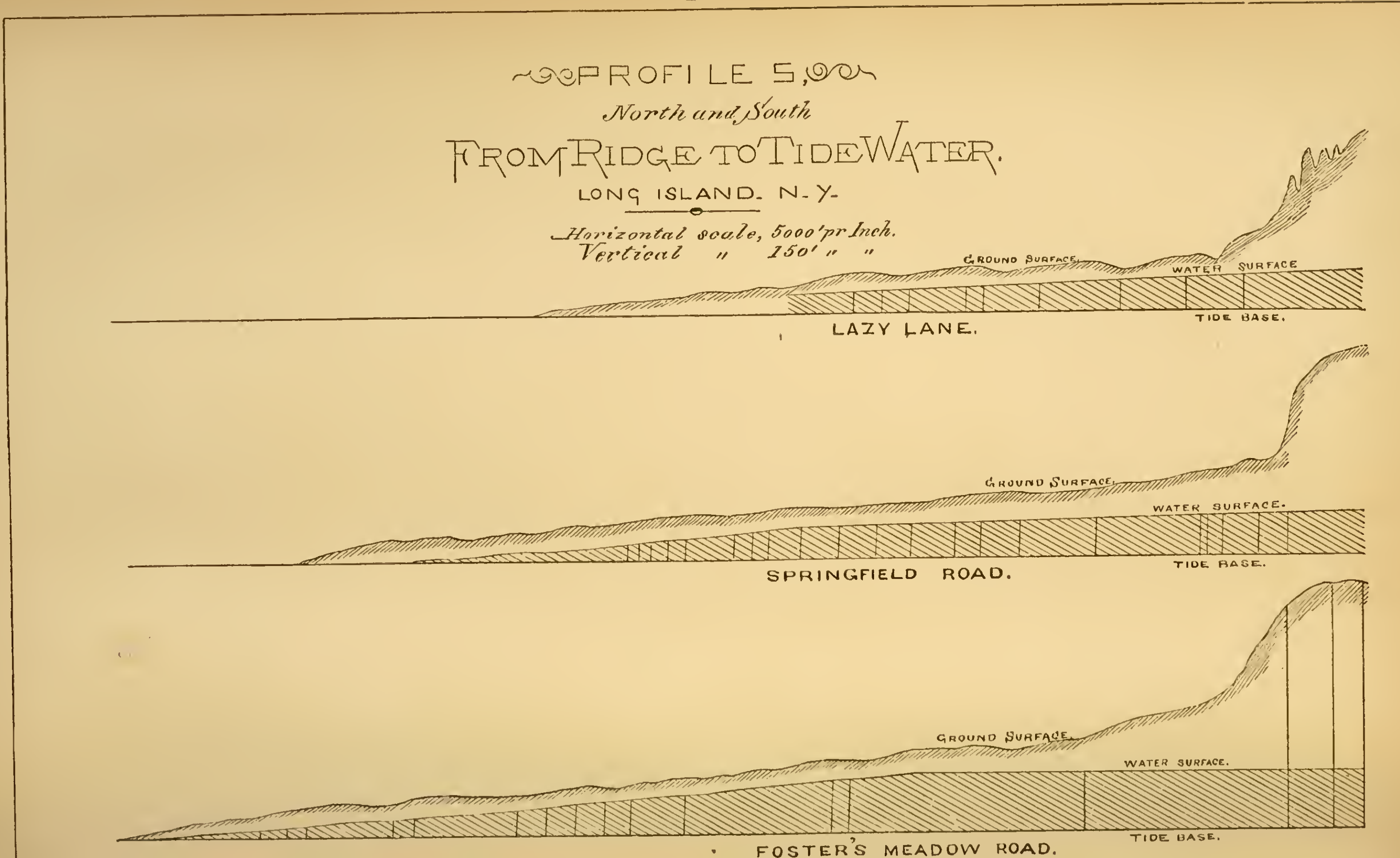
If we consider the character of the water obtained by these various methods, there are certain general facts that are at once and readily noticeable. As already stated, the water thus obtained is generally clear and colorless: it is of a quite uniform temperature, cool therefore in summer, and in winter much warmer than the water of neighboring ponds and rivers, which, of course, approach in temperature very close to the freezing-point. The water also differs in chemical character from that of neighboring streams or ponds, generally being somewhat harder.

[1] This was the case in the "filtering-gallery" of Toulouse. "Le premier filtre donna d'abord de fort bonne eau; mais, dès la deuxième année, une végétation de plantes aquatiques commença à s'y établir, et à altérer la qualité de ses produits. L'année suivante, le mal empira: les rayons du soleil traversant sans obstacle une couche d'eau mince et transparente, atteignaient le fond dans toute leur intensité; ils y développaient une forte chaleur, laquelle était encore augmentée pas l'effet et la réverbération des bords et des digues. Par suite, la végétation y acquit une vigueur extrême; les divers moyens employés pour la détruire furent sans effet; des reptiles s'y joignirent. Ces plantes et ces animaux, en mourant et se putréfiant dans une eau tiède, la rendaient très mauvaise.

"Il fallut se presser de porter un remède au mal; encore un an, et il eût été absolument intolérable. L'eau était très bonne en entrant dans le filtre, et vicieuse lorsqu'elle en sortait. La forte chaleur et la lumière en étaient la cause manifeste; il fallait l'attaquer. On ne le pouvait qu'en couvrant le filtre; j'en émis l'idée: on remplit le fond avec des cailloux et puis on le combla.

"Depuis que le filtre a été ainsi disposé, la qualité des eaux s'est non seulement rétablie, mais améliorée." . . . — D'Aubisson, *Annales des Ponts et Chaussées*, 1838; also quoted in Dupuit, de la Distribution des Eaux, p. 122, and in Dupasquier, des Eaux de Source, etc., p. 144.

Fig. VII.



PROFILE 5,
North and South
FROM RIDGE TO TIDE WATER.
LONG ISLAND. N.-Y.
Horizontal scale, 5000' pr Inch.
Vertical " 150' " "
GROUND SURFACE.
WATER SURFACE
TIDE BASE.
LAZY LANE.
GROUND SURFACE.
WATER SURFACE.
TIDE BASE.
SPRINGFIELD ROAD.
GROUND SURFACE.
WATER SURFACE.
TIDE BASE.
FOSTER'S MEADOW ROAD.

Although for many practical purposes it is sufficient to know that the water procured is of good quality, it will be interesting and perhaps profitable to inquire somewhat into the proximate source of the water thus obtained. I say proximate source, for of course the rainfall is the ultimate source from which all our available water comes.

Over limited areas the upper surface of the ground-water may be nearly horizontal: there is, however, almost always an inclination and a more or less sluggish movement towards a lower level, a river, or a lake. Although there do occur actual underground streams flowing with greater or less velocity, especially in rock formations which abound in fissures, in sandy or gravelly deposits, which are tolerably homogeneous, it is seldom strictly correct to characterize the movement of the water as a *flow* in the sense in which we apply the term to streams above ground. The term is, however, so convenient that it may be used if it be not misinterpreted.

The inclination of the ground-water depends mainly upon the character of the water-bearing stratum itself: where this is thin, the configuration of the underlying impervious stratum exerts some influence, especially in determining the direction of the flow; configuration of the surface has very little influence in the matter, and can seldom give any reliable indications of the water-level beneath it.

A number of careful observations have been made on the level of the ground-water in different places, and its variations, together with its relation to neighboring streams or ponds. To American readers, the most extensive of such as are readily accessible are in the Report of the Brooklyn Water Commissioners on the Brooklyn Water-Works and Sewers: New York, 1867.

Where the character of the water-bearing stratum is tolerably uniform, and the underlying impervious stratum is at a considerable distance from the surface, there is generally a more or less uniform increase in the height of the ground-water as we recede from the shore. This is well marked in the case of Long Island, where there is a quite uniform slant from the central ridge to the ocean or to Long Island Sound. The average inclination is about seven feet to the mile. From the many profiles in the Brooklyn Report alluded to, a few for the sake of illustration appear in Fig. 7, opposite.

In some localities the inclination is much greater than this for limited distances; thus, in the neighborhood of the Taunton Water-Works there is a fall, in what seems to be a continuous water-table, of about 14 feet in 1,000.[1]

Now, what happens when a well is sunk into the ground-water? We will first take the case of a well like that in the Prospect Park, Brooklyn, N.Y. This well is nearly two miles from tide-water, and the level of the water in the well is 13 feet above tide. It is, therefore, far removed from any large body of water which could be supposed to influence it. In such a case as this, of course the mere opening of the well makes no difference in the natural level of the water in the same stratum; but when water is pumped from the well the level of the ground-water is lowered for a certain distance in every direction. If the water-level in the well be kept for a sufficiently long time at a certain fixed point, by pumping as much as may be necessary, the ground-water around the well in every direction also assumes a constant level. The form of the water surface will be understood from Fig. 8, which represents a section through the well; the water-level being indicated by the curved line which lies above the straight line joining the two points *a* and *b*. The exact shape of this curve, its distance above the straight line,

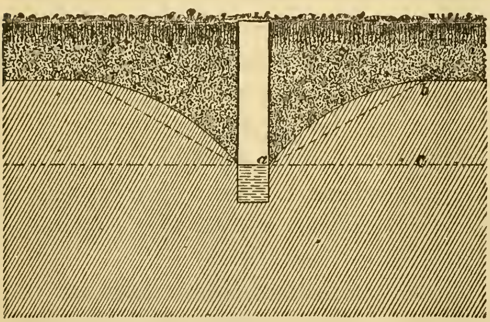


Fig. 8.

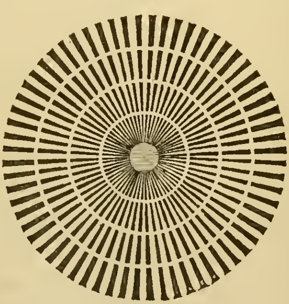


Fig. 9.

[1] A great many profiles resulting from actual measurements, and showing the inclination of the ground-water, may be found in the Berlin and Munich reports, the titles of which appear on pages 224–226. In the latter the profiles include the surface levels, the level of the ground-water, and the level of the underlying impervious stratum, and are very instructive.

will depend mainly upon the nature of the ground, as will also the quantity of water which must be pumped in order to maintain a constant level in the well, and also the point *b*, which is the outer limit of the measurable influence on the ground-water. Of course this influence is in every direction as shown in the plan, Fig. 9.

Although perhaps somewhat difficult at first to obtain a clear idea of the matter, this taking of water from the ground-water differs in almost nothing from taking water from a lake or pond. Suppose that we have a lake or pond, as there are many, generally situated in valleys, with no considerable visible inlet, and yet from which experience has shown that a certain number of gallons daily can be withdrawn without affecting its level. If this lake be now filled with sand and gravel, we can still pump the same daily *quantum* (even more, owing to lessened evaporation) ; but, owing to the resistance of the material, the level of the water does not equalize itself at once, and for a certain limited distance the water forms a curved surface of the same general character as would be formed by water flowing through a bank of sand or gravel if the water-levels on the two sides of the bank were different but constant. The character of that curve, as ascertained by experiment, I shall speak of later. (See page 195.) To return now to our well. If the demand made upon the well be increased, — that is, if the level of the water in the well is kept constantly at a lower point, — the circle of influence is extended, but not in proportion to the increased supply. Theoretically, in a perfectly homogeneous material, if the ground-water were lowered through a double distance, the influence would be felt twice as far; i.e., the circle of influence would be four times as great. Practically, these theoretical conditions would be only partially realized, as it would be impossible to have a perfectly homogeneous deposit. Of course, in order that the well should give a uniform supply, the amount of rainfall received over the region drained, and over the region which contributes to the underground supply, should be uniform. The level of the ground-water is subject naturally to some variations, according as the season is wet or dry. If there were no rainfall, the ground-water would be lowered eventually throughout the entire water-bearing stratum, practically to very nearly the level of the

water in the well; or, to refer to the Figure 8, the point *b* would recede farther and farther until for some distance the curve *a b*, the straight line *a b*, and the straight line *a c* would all three practically coincide. That is to say, if the lake which we took for comparison were no lake, but a cistern, it would be eventually pumped dry, or to the level of the suction-main.

The general principles relative to the effect of pumping upon the ground-water in the same tolerably homogeneous stratum are not matters of conjecture or theory, but have been determined by experiment. I may refer to Salbach's Report on the Dresden Water-Works, from which figures Nos. 9 and 10 are taken. In the experiments which were there very carefully conducted in the alluvial deposit on the banks of the Elbe, from which the water has been taken for the supply of the city, it was found that when the water in an experimental well was, by pumping, kept constantly 2.5 meters below its normal level, the height of the ground-water was affected in every direction for a distance of 60 meters (about 200 feet), and that the curve which the level of the ground-water assumed was the same as represented in the Figure 8. (If the figure is to apply to this particular case, the vertical scale is to the horizontal as 10 to 1, and the diameter of the circle is 120 meters.) Beyond this point the effect was inappreciable. The Figure 10 represents what

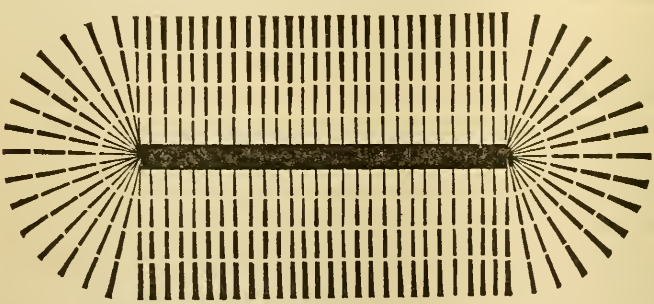


Fig. 10.

would be the effect of a series of such wells connected together, or, what amounts to the same thing, a pervious gallery in which the water was kept at the same constant level. It is to be borne in mind, that in the case referred to, the gravel was extremely porous, and the well was located very near the bank of the river. The amount of water

necessarily pumped, in order to keep the level at the point indicated, was 1.56 cubic meters per minute (about 600,000 United-States gallons per day).

In comparing the ground-water to a lake, we overlook one important point, namely, the movement of the ground-water. A more just comparison in many cases would be to compare it to a pond formed by the enlargement of a stream, where there is a continual inflow and discharge, although the current is hardly noticeable.

The most favorable situation for a gathering well, basin, or gallery, is therefore in the neighborhood of a lake or river, for two reasons; first, because at such a place there is almost certain to be a decided movement of the ground-water towards the stream; and, in the second place, the water from the river can make up any deficiency caused by removal of the ground-water.[1]

It was formerly supposed, and is so even now by many persons who have not made a study of the subject, that in such cases the water is derived directly from the river, and filtered by passing through the intervening sand and gravel. While I would not deny that in some cases even a considerable amount of water comes from the stream, I believe that as a rule the smaller proportion of the water is thus derived, and in many cases none at all.

That it is not necessary in all cases to call upon the stream directly to explain the source of the water, is evident, if the above explanation of wells sunk at a considerable distance from any stream is correct. Suppose, for the moment, that the bank of the river is actually water-tight: it is manifest, that, instead of a "circle of influence," we have now to deal with a "semicircle;" otherwise things are as before.[2] The bank is not, however, as a rule, even practically water-tight; but in the natural condition there is, at least where

[1] Hereafter, in speaking of "collecting-wells near the banks of a stream or river," it will be understood that the term "well" shall include also open or covered galleries or basins, and that the term "stream" or "river" shall also include "ponds" or "lakes." The essential points are the same in any of these cases.

[2] If the level of the water in the well were kept below the bottom of the river, the circle of influence might then be completed on the other side of the stream: if by so doing the tendency was to lower the level of the ground-water, and leave a vacuous space under the bed of the river, the river-water would work its way down to fill the gaps, and in that way water would be obtained from the stream.

the ground is sandy or gravelly, a continual passage of the ground-water into the stream. It is well known that a river passing through an alluvial deposit of sand and gravel generally increases in size as it flows, even when no visible streams add to its volume. The observation has also been made again and again, that the water in shallow wells situated at some distance from a river stands at a higher level than in the river itself. This was clearly shown by measurements made for a considerable period in Berlin, Germany, on a large number of ordinary and bored wells all over the city, and at different distances from the Spree. Here it was supposed that the impurities of the river were fouling the wells of the city; but these experiments showed that the ground-water in the region lying about the river was really at a higher level, and that the movement was towards the river; and many experiments since that time have shown the same thing.

It is well known that wells may often be sunk very near to tide-water, may rise and fall with the tide, and yet yield fresh water; in the same way the level of the ground-water along any stream is determined by the height of water in the stream. Let us consider the explanation of this fact. Suppose the tide falls, or the water in the river is lowered. The ground-water level also falls, but more slowly, on account of the resistance of the ground, and continues to fall after the tide or stream begins to rise. The rising water, however, reaches the point to which the ground-water has fallen; and, as it continues to rise, it causes the setting-back of the ground-water, or at least interrupts its flow. The level of the water in the ground then rises somewhat as is represented in Fig. 11, No. 2 (op. p. 195). Here the several curves may represent the successive levels of the ground-water, as the stream or tide successively reaches the points indicated by the right-hand extremities of the lines. If the ground is very porous, and there is little flow to the ground-water, the water from the outside may work into the bank, but the distance will be a limited one. Sometimes, in the case of a sudden flood, the water may for a time stand considerably higher in the river than in the ground in the immediate vicinity. Other things being equal, the passage of water from the ground, into the bed of a river, is much

more easy than its passage from the river into the ground; for the particles of silt deposited on the bed of the river, choke the passages between the grains of sand and gravel, and become, as it were, wedged in. Pressure from the outside tends to make the mass more compact and less pervious; but, if pressure be applied from the inside, the particles of silt are forced out or lifted as valves from their seats. If the condition of things be as just stated, it must be ordinarily possible to intercept and appropriate a certain amount of water by means of a well or gallery, without drawing water from the river itself, although it would be extremely difficult to estimate what this amount might be in any given case except by inference from gaugings of the stream above and below the point in question.

It is not strange that the river or pond should be assigned as the source of the water which is actually obtained; for, in the first place, it seems to the ordinary mind hard to believe that such a large amount of water can be drawn day after day from no visible source, even if the fact of a general natural flow towards the river be admitted. It also sometimes happens that wells which are situated in very porous deposits near tide-water, and from which considerable quantities of water are taken, become brackish, indicating that the sea-water does sometimes find its way through the gravel. On the other hand, there are many facts which tend to show the contrary, and which I will mention in a general way, and then proceed to describe certain particular instances where observations have been made. The yield of course varies in different localities; but it is generally true that while increasing the bottom area of the basin, or its length in the direction of the stream, increases the amount of water obtained, this increase is not in proportion to the area or length. It is almost invariably found that the temperature of the water thus obtained is nearly uniform from season to season, while that of the river is subject to considerable variation. Often also the water differs very much in particular respects; such, for instance, as in hardness, which will make itself evident by its effect when the water is employed for washing, or in steam-boilers. In this neighborhood the difference in hardness is not great, although in time it shows itself by the formation of boiler-scale. Belgrand gives a number of ex-

amples from French localities, from which I may cite the following:[1] —

Water of Rhone, at Lyons,	16°
Water of filtering-gallery at Lyons,	17.94
Water of Loire, at Nevers,	4.96
Water of collecting-well,	20.70
Water of Loire, at Blois,	7.76
Water of the gallery (which is beneath the bed of the river),	14.45

Sharples has found[2] that the water in the filter-gallery near Little Pond, Cambridge, contains nearly twice as much lime as that of the pond, and instances might be multiplied indefinitely. In the case of the Dresden water-supply before alluded to, the river-water is harder than that obtained from the collecting-wells.[3]

Even when the gallery or well is sunk directly in the bed of the river, or in an island surrounded on all sides by the river or pond, the ground-water still contributes largely or wholly to the supply. Many experiments have shown that the water in a gravel-deposit directly beneath a river differs essentially from that of the stream itself.

I now proceed to give a few instances of observations which have been made in particular cases. The city of Toulouse, in France, is supplied by a number of filtering-galleries in a gravel-deposit on the banks of the Garonne. The original gallery was built in 182– at a distance of about 60 meters (200 feet) from the river. This furnished water acceptable in quality, but deficient in quantity; an increase of the length of the gallery failed to furnish a corresponding increase in quantity of water obtained. A second filtering-gallery, or rather series of connected wells, was constructed nearer to the river, at a distance, in fact, of only 10 meters. In this case, the water obtained manifestly did come, in part at any rate, from the river: the river was somewhat turbid, and, what is very instructive, the passage through a bank of thirty feet, and admixture of course with some ground-water, failed to bring the water to any thing like the uniform temperature of the other galleries. The temperature fell in winter to 2° C.

[1] La Seine, &c. pp. 463 and following.

[2] Twelfth Annual Report of the Cambridge Water Board, for the year 1876. Boston, 1877; page 30.

[3] Salbach. Das Wasserwerk der Stadt Dresden; 3 Theil, page 7.

(36° F.), and in summer rose above 21° C. (70° F.).[1] This gallery was therefore abandoned, and others constructed at a greater distance from the stream. These furnish water which is satisfactory, except when in time of flood the river covers the whole territory in which the galleries are built.

Lowell, Mass.—In the Fifth Annual Report of the Board of Health may be found an account of the examination of the water in the filtering-gallery at Lowell, as compared with the water in the river; and it is not necessary to enter into any further discussion at this place. The conclusion reached was, that the river could not be regarded as supplying directly the whole of the water obtained. Since that time the supply has proved inadequate to the demand, and it has been necessary to use unfiltered river-water.

Waltham, Mass.—The case of Waltham was also mentioned in the report alluded to, and chemical examinations of the water of river and filter-basin were made: I have had occasion to study the question somewhat further since the date of that report.

The water-supply of Waltham is pumped from a so called "filter-basin" on the banks of the Charles River. This basin was constructed at the side of the stream, partly by making an excavation into the knoll at the foot of which the basin is situated; and partly, on three sides in fact, by enclosing a portion of the river by a gravel embankment some fifty or sixty feet wide. This embankment slopes outward on the river side, but is walled perpendicularly on the side towards the basin. The idea at first was, that the river-water should *filter through* this gravel embankment, and the filtered water should then be pumped into the reservoir, and distributed for domestic use. Practically, it seems, however, that the basin draws the main portion of its supply, not from the river, but in part from the ground-water proper, and in part from actual springs rising from a lower level,—from what we might call an *under*-ground water. Even casual observation would lead to this conclusion. In the first place, it was noticed, before the construction of the basin, that in winter there was generally open water at this point in the river, or,

[1] "Se trouvant trop près de la rivière, elle en conserva trop la temperature; dans l'hiver dernier, sa chaleur a diminué, jusqu'à n'être qu'à 2° du thermomètre, et, dans l'été, elle va a plus de 21°."—D'Aubisson, *Ann. des Ponts et Chaussées*, 1838.

when ice did form in extreme cold weather, that it was thinner than on the river itself, indicating the entrance of warmer water from the land. Further, during the construction of the basin it was found that water came into it so rapidly from springs, that it was necessary to pump at the rate of 4,000 gallons per minute in order to remove the water that the work might go on: moreover, the water sometimes stands higher in the basin than in the river, and the temperature is quite uniformly 49° or 50° F. The pumps do not work on Sunday; and on Monday morning, when the weather is cold, the water which has then stood in the basin some thirty-six-hours is found to be skimmed over with ice, having acquired at the surface a low temperature; but during the week, as the water is constantly renewed and constantly supplied, it is found that the temperature varies but slightly.

It has been also observed, that, while the Charles-river water has no effect on steam-boilers, the water from the basins causes a slight incrustation after some time, although the basin-water is itself very soft.

I was requested in the year 1876, by the Water Commissioners of Waltham, to make some examinations which might lead to an opinion as to the source from which the bulk of the water came. The experiments as planned were never fully carried out, but the investigation proceeded far enough to confirm the view above expressed. The report containing the results of my observations was never printed; but, by permission of the Water Commissioners, I can quote somewhat freely from it in this place, avoiding, as far as possible, repeating what has been already stated in the Fifth Annual Report of the Board already alluded to.

Many examinations have shown that the basin-water contains much less ammonia and "albuminoid ammonia" than the water of the river, that the total dissolved matter is somewhat greater, and that it consists in a larger proportion of mineral matter. See Table VI. Owing to the smaller proportion of vegetable matter, the water in the basin is clear and colorless.

TABLE VI. — *Examination of Water from Waltham, Mass.*

[Results expressed in parts per 100,000.]

Number.	Date.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.			Chlorine.	Silica.	Sulphuric Acid (SO_3).	Lime.	Height of Water in River.	Height of Water in Basin.
					Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.						
	1876.												
1	Aug. 1,	River, . .	0.0107	0.0259	3.08	1.84	4.92	–	0.48	0.27	0.68	3.01	0.90
4	Aug. 12,	River, . .	–	–	2.90	1.68	4.58	0.38	0.47	–	0.65	1.45	–
8	Aug. 23,	River, . .	0.0069	0.0253	2.60	2.36	4.96	0.33	0.77	0.33	0.66	2.02	0.60
2	Aug. 1,	Basin, . .	0.0016	0.0075	4.84	0.80	5.64	–	0.95	0.31	1.15	3.01	0.90
3	Aug. 12,	Basin, . .	–	–	5.44	1.02	6.46	0.42	1.01	–	1.14	1.45	–
7	Aug. 23,	Basin, . .	0.0016	0.0067	5.34	0.80	6.14	0.30	1.57	0.32	1.08	2.02	0.60
16	Aug. 26,	Basin, . .	–	–	5.40	0.42	5.82	0.19	1.29	–	1.42	1.89	— 0.48

The first question which would naturally arise is, whether it would be possible for the water of the river, in passing through the bank of gravel some 50 or 60 feet thick, to become changed so as to be similar to the water in the basin.

I answer that it is not *impossible;* and, to determine the probability in this case, I have made a variety of experiments. In the first place, I examined the gravel of which the bank is made, and found that it is not destitute of soluble matter. In fact, a portion treated for a number of hours with boiling water gave up to the water 0.02% (two one-hundredths of one per cent) of its weight of soluble matter. In order to judge of the probability of the solution of mineral matter by the percolation of the river-water at ordinary temperatures, some gravel taken from the bank (and which had been screened through a sieve of three meshes to the inch) was packed in several lengths of four-inch lead pipe connected together so as to form a column about 22½ feet in length, and supported in an inclined position. Through this gravel I allowed to flow slowly (with a single interruption when it was necessary to alter slightly the situation of the pipe), for a number of weeks, a constant stream of Cochituate water, — a water very similar to that of Charles River. The water as it flowed from the end of the pipe was examined chemically at several different times. It was found that the water lost a large proportion of the vegetable matter dissolved in it, and that it became brighter and less colored. At first there seemed to be also a slight loss of mineral matter; but after a time there was practically no difference between the amount of mineral matter in the water before and after filtration.

Observations of the Relative Levels of Water. — While the level of the water in the basin would naturally be slightly above that of the river, and is indeed so when the pumping is interrupted for a sufficient length of time, ordinarily the river level is higher. Pumping is always discontinued at night; and then the water in the basin rises, at first rapidly, afterwards more slowly, but does not, as a rule, rise as high as the water in the river before pumping begins again. The question may be asked: If the water comes *through the bank*, as it was at first supposed that it would, what level would the water in the bank assume? In order to obtain an answer to this question by actual experiment, I had constructed a

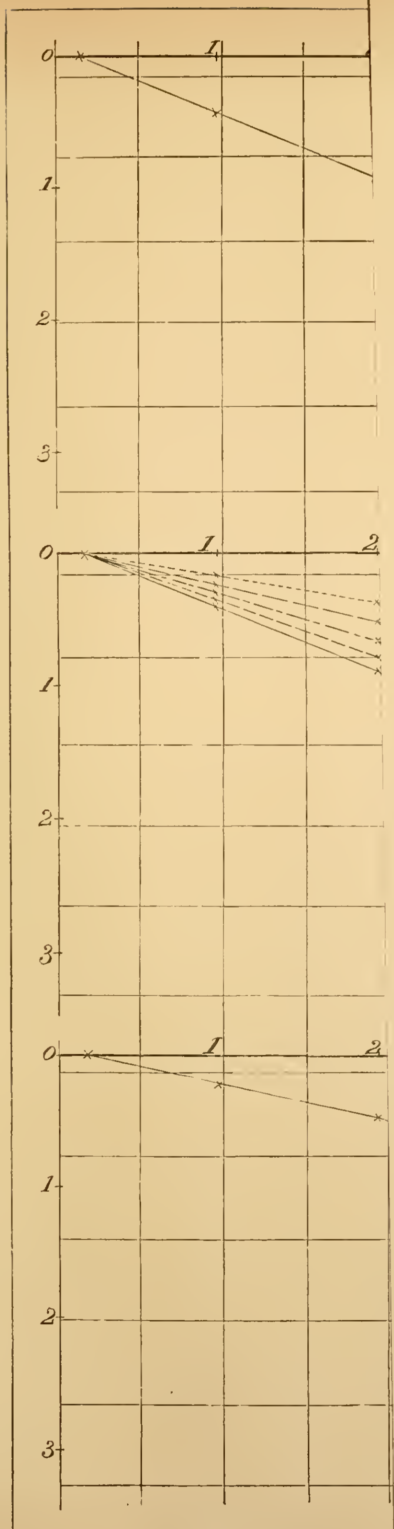
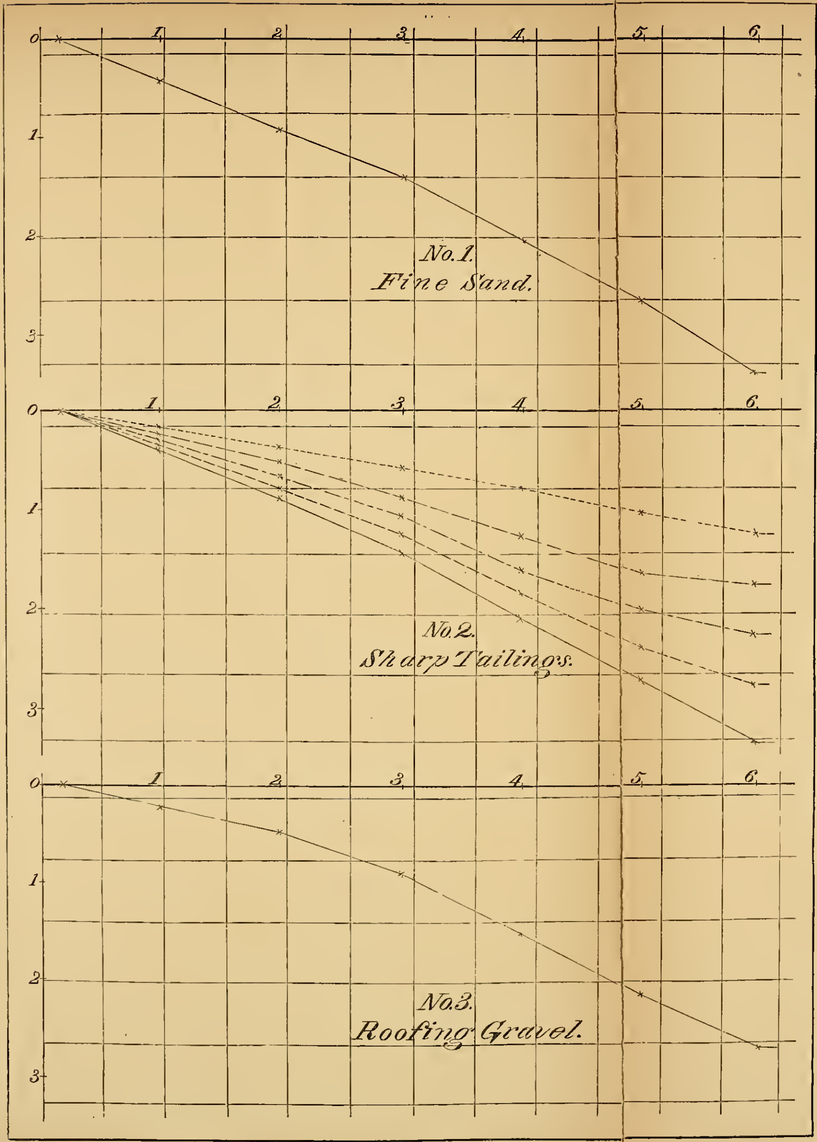


Fig. XI.


1
2
3
4
5
6
0
1
2
3
No. 1.
Fine Sand.
No. 2.
Sharp Tailings.
No. 3.
Roofing Gravel.

box six feet long, four inches wide, and six inches deep, so arranged that when it was filled with sand or gravel I could keep a constant level of water at either end. This box was filled on different occasions with a variety of materials; and by means of glass tubes properly arranged, I was able to determine the level of the water in the sand at different points.[1]

Fig. 11 represents several of the curves obtained: in each case the difference of level was about three inches; in one case (No. 1) was used fine Berkshire sand, through which the water flowed with considerable difficulty; and in No. 3 common roofing-gravel was used. Whatever material was experimented with, — whether fine sand well compacted, through which the water passed very slowly, or roofing-gravel through which the water ran rapidly, — the general character of the curve was the same.[2] Fig. 11, No. 2, shows the effect of the gradual rise of water such as occurs in the basin when filling up. The lower curve represents the condition of things in the experimental bank when there was three inches difference of level: the outflow was then stopped, and as the water rose in the sand its height at different stages was noted. It will be noticed that the water-level rises throughout its whole extent, although not uniformly. It was therefore evident, that, if there was *free* passage of water through the bank, water would be found in the centre of the bank at a level nearly midway between that of the river and that of the basin. I then had driven into the centre of the bank, at two different points, iron pipes, such as are used in driven wells, terminating just below the bottom of the basin. These pipes we will call A and B. Several sets of observations were made on the relative levels of the water in these tubes; two of these

[1] Without going fully into all the precautions taken to insure accurate results, I may say, in reply to questions which would certainly arise in the minds of any who have made such experiments, that, in order to avoid the passage of water at an unequal rate along the sides and bottom of the trough, the box was painted inside and well sanded: also there was always a depth of about two inches of sand, or rather of dead water, below the point of outflow. Of course, for measuring the delivery of any particular material, such an experiment would be worthless; but the general character of the curve, which I wished to ascertain, could be reached accurately enough.

[2] In these diagrams, the vertical scale is ten times as great as the horizontal. It is evident that the curve lies in each case somewhat above the straight line joining the points which indicate the level of the water on the two sides of the bank; but for all practical purposes this curve may be taken as a straight line.

sets are given in the accompanying tables. The second set of measurements here recorded I made myself, and with very great care.

TABLE VII. — *Observations on Water Levels, Waltham Water-Works.*

Measurements made by T. W. ROBINSON.

[Heights stated in feet above zero of gauge in basin.]

Date.	Hour.	River.	Pipe A.	Pipe B.	Basin.	REMARKS.
1876.						
Aug. 23,	6 A.M.,	2.10	1.76	1.76	1.88	
23,	9 A.M.,	2.05	0.80	0.78	0.84	
23,	12 M.,	2.00	0.39	0.48	0.35	
23,	3 P.M.,	1.99	—0.04	0.06	—0.16 [1]	
23,	6 P.M.,	1.94	—0.27	—0.17	—0.46 [1]	
23,	9 P.M.,	1.97	0.29	0.36	0.25	Pumping stopped at 7 P.M.
24,	6 A.M.,	1.99	0.96	1.03	1.00	Pumping began at 5½ A.M.
24,	9 A.M.,	1.94	0.33	0.41	0.32	
24,	12 M.,	1.88	0.06	0.06	—0.21 [1]	
24,	3 P.M.,	1.85	—0.24	—0.24	—0.51 [1]	
24,	6 P.M.,	1.79	—0.54	—0.44	—0.71 [1]	
24,	9 P.M.,	1.82	0.11	0.16	0.19	Pumping stopped at 7 P.M.
25,	8 A.M.,	1.88	1.31	1.32	1.31	No pumping Aug. 25.
25,	11 A.M.,	1.83	1.40	1.41	1.42	
25,	7½ P.M.,	1.80	1.51	1.56	1.59	
26,	8 A.M.,	1.91	0.76	0.86	0.79	Pumping began at 5½ A.M.
26,	11 A.M.,	1.89	0.21	0.31	0.21	
26,	2 P.M.,	1.90	0.06	—0.12	—0.36	
26,	5 P.M.,	1.89	—0.24	—0.33	—0.61	

[1] In the case of these (5) observations, the measurements were not made with as great accuracy as the others, and they may vary 0.1 foot from the truth. In the other cases the limit of error may be 0.05.

TABLE VIII. — *Observations on Water Levels, Waltham Water-Works.*

Measurements made by W. R. NICHOLS.

[Heights stated in feet above zero of gauge in basin.]

Date.	Hour.	Pipe A.	Pipe B.	Basin.
1877. Feb. 9,	6.45 P.M., ...	1.76	–	1.73
9,	6.55 P.M., ...	1.86	–	1.81
9,	7 P.M., ...	1.885	–	1.86
9,	7.15 P.M., ...	2.01	–	1.975
9,	7.30 P.M., ...	2.10	–	2.095
9,	7.45 P.M., ...	2.18	–	2.18
9,	8 P.M., ...	–	2.275	2.26
9,	8.30 P.M., ...	2.41	–	2.39
9,	9 P.M., ...	–	2.56	2.525
9,	9.30 P.M., ...	2.63	–	2.63
9,	10 P.M., ...	–	2.75	2.735
9,	10.30 P.M., ...	2.82	–	2.82
9,	11 P.M., ...	–	2.91	2.91
9,	11.30 P.M., ...	2.98	–	2.99
9,	12 P.M., ...	–	3.07	3.06
10,	12.30 A.M., ...	3.12	–	3.12
10,	1 A.M., ...	–	3.19	3.185
10,	1.30 A.M., ...	3.23	–	3.24
10,	2 A.M., ...	–	3.29	3.30
10,	2.30 A.M., ...	3.33	–	3.345
10,	3 A.M., ...	–	3.39	3.395
10,	3.30 A.M., ...	3.41	–	3.43
10,	4 A.M., ...	–	3.47	3.47
10,	4.30 A.M., ...	3.48	–	3.51
10,	5 A.M., ...	–	3.54	3.555
10,	5.30 A.M., ...	3.55	–	3.58

These observations show that the water in the middle of the bank follows very closely that of the basin. When the water in the basin is considerably lower than that of the river, and still falling, the water in the basin is somewhat lower than in the bank. This may indicate that with the head which then exists there is passage of a small amount of water through the bank. The difference of level is not, however, so marked except when the river is very low: at such times when the basin is pumped down the shelving bottom is exposed, and this practically makes the bank many feet thicker. When the basin begins to fill, the level rises a trifle more rapidly in the basin than in the bank at first, but afterwards at nearly the same rate; before, however, the water in the basin reaches that of the river, the level in the basin is slightly above that in the bank. It thus would appear that although the bank is not perfectly water-tight, for practical purposes it may be regarded as quite impervious and as forming a part of the basin.

Observations on the Temperature.

Observations show that while the temperature of the basin at different points differs, and while in some instances at the same point the temperature is subject to variation, the water as drawn from the conduit is tolerably uniform. The basin being quite shallow, and having a sandy bottom, if the water were supplied mainly from the river and exposed in this basin to a summer's sun, the water would naturally become heated to a temperature higher than that of the river. Continuous observations made from Aug. 23 to Aug. 26 showed for the river an average temperature of 74° F., and for the basin an average temperature of 62.8° F. In the basin the variation from morning to noon was found to be, as we should expect, much greater than in the river; and it seems to me necessary, in order to account for the observed facts, that the temperature of the water entering the basin should be considerably below the temperature observed in the basin.

TABLE IX. — *Observations on Temperature, Waltham. (In degrees Fahrenheit.)*

Date.	Hour.	10 inches below surface. River at Gauge.	10 inches below surface. River at Pipe C.	Pipe B.	Pipe A.	Basin at efflux 10″ below surface.
1876.						
Aug. 23,	6 A.M., . . .	69.9	70.2	68.2	72.3	59.0
23,	9 A.M., . . .	72.5	71.1	68.4	72.3	59.9
23,	12 M., ...	73.4	73.9	66.2	71.5	65.3
23,	3 P.M., . . .	75.2	77.0	68.0	71.5	67.9
23,	6 P.M., . . .	75.2	74.7	68.0	70.5	60.8
23,	9 P.M., . . .	73.4	73.4	67.4	70.1	56.3
24,	6 A.M., . . .	71.2	71.2	67.8	71.4	55.4
24,	9 A.M., . . .	71.4	70.7	65.8	71.4	58.1
24,	12 M., ...	72.5	72.5	68.0	71.1	63.0
24,	3 P.M., . . .	74.3	75.2	67.8	71.1	63.5
24,	6 P.M., . . .	75.2	75.2	67.6	70.4	57.6
24,	9 P.M., . . .	73.4	73.6	67.8	70.0	55.4
25,	8 A.M., . . .	72.5	72.5	68.6	71.1	60.4
25,	11 A.M., . . .	74.2	75.8	68.7	71.4	64.4
25,	7½ P.M., . . .	77.0	76.0	68.2	71.6	69.8
26,	8 A.M., . . .	74.8	73.7	68.6	71.4	68.4
26,	11 A.M., . . .	76.3	75.0	68.0	70.7	70.2
26,	2 P.M., . . .	77.4	77.7	68.4	70.5	71.6
26,	5 P.M., . . .	78.3	77.6	68.0	70.5	66.2
		74.1	74.0	67.9	71.1	62.8

NOTE. — The pipe B was situated nearer to the natural bank, and at a less exposed part of the embankment.

I have on various other occasions observed the difference in temperature between river and basin, which is as marked in winter as in summer. For instance,

	Temperature of Air.	Temperature in River.	Temperature in Basin.
Feb. 7, 1874 (day), ...	19° Fah.,	36° Fah.,	44–45° Fah.
Feb. 9, 1877 (night), ...	14° Fah.,	32° Fah.,	48° Fah.

On the last occasion the temperature in the middle of the bank was about 39°. There is, it is true, considerable difference between the temperature of the water in the basin in winter and in summer, owing to the fact that the surface exposed to the air is great compared with the depth of water. If the basin were covered over, this difference would no doubt be much less.

It may also be said that the river in the neighborhood of the filtering-works is very sluggish, being practically a long mill-pond, and would naturally deposit silt on the banks so as to prevent even an artificially constructed bank from being long pervious to water. Although the river may contribute somewhat to the supply, it seems to me that in this case the larger portion of the water is intercepted and not derived. On one occasion when the river had been purposely drawn down for some weeks, I noted the height of the water in the ground at a point some 500 feet from the basin and about 100 feet from the nearest point of the river. The water was found to be several tenths of a foot below that of the river, showing that at that time the influence of the pumping was felt on the ground-water for the distance of 500 feet. On a subsequent occasion when the river was high, the level was practically the same at this point and in the river.

Taunton, Mass. — Taunton is supplied from an uncovered basin situated near the Taunton River, which at this point feels the tide although the water is not brackish.

"The filter basin or canal was constructed 400 feet in length, with side slopes of two feet horizontal to one foot perpendicular, both on the inside of the canal, also on the face or river side, the bottom of the canal being 8 feet below mean low-water mark, and the top or embankment 13 feet above, or a total depth of 21 feet from the top of embankment, which on the river side is 15 feet in width on top and 100 feet at bottom. The width of canal at bottom is 17, at top 101 feet, paved with stone on each slope for a distance of 18 feet from the bottom: the balance is sodded." [1]

There is also a pump-well some 28 feet deep. The idea in the construction was, as I am informed, that the river-water should filter through the bank into the basin, and the possible yield of the basin was anticipated to be one and one-half

[1] First Annual Report of the Water Commissioners of the City of Taunton, Dec. 1, 1876.

million gallons per day; the nature of the bank, however, which is artificial, and is composed of a mixture of gravel and clay, is such that it would soon become impervious to water, and would make a better dam than filter. It would be safe to say that practically no water is obtained directly from the river. Owing to the depth of the pump-well, and to the fact that the deposits of clay are here very irregularly distributed, it is impossible to say whether the water all comes from the same stratum or not, or how far the stream may contribute to the ground-water. The ground rises back of the basin; and the level of the ground-water, in what seems to be a continuous stratum between two layers of clay, has been found to rise some 14 feet in 1,000, beyond which point the water-level is more nearly horizontal.

Some observations on the water-levels of the basin and in the neighboring region were made last fall by Mr. A. H. Martine, civil engineer, from whose results I make the following statements. The highest tide observed by Mr. Martine caused the water in the river to stand at 9.28 feet above a certain zero, and the lowest tide 4.29 feet. What the level of the water near the river was before the basin was opened, we have no means of knowing, but it was probably somewhat below the point reached by the highest tide; and as the ground is not very pervious it was probably considerably above the point lying midway between high and low tide, perhaps at 8½ feet above the zero referred to. The water ordinarily stands in the basin at 6½ or 7 feet, and the amount of water pumped daily is estimated at 250,000 gallons. It seems that the pumping of this amount does not require the lowering of the natural level of the ground-water more than two feet. At the time referred to last fall, it was found that to keep the level some five feet lower than this, about 600,000 gallons daily were pumped. The water in the basin was kept at this lower level for five days; and during that time the level of the ground-water was not affected at a distance of 320 feet, although it was affected at a distance of 80 feet from the basin. The exact limit of measurable influence could not be ascertained without continuing the experiments for a longer time. Chemical examination of the water in the river and in the basin was made last August: the results are included in the following table.

TABLE X. — *Examination of Water from Taunton.*

[Results expressed in parts in 100,000.]

Date.	LOCALITY.	Water as Received.		Water after Filtration through Paper.		Solid Residue.			
		Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.	
1877. Aug. 14,	Reservoir, ...	0.0088	0.0099	–	–	3.80	1.80	5.60	Unfiltered.
		–	–	0.0088	0.0091	3.48	1.76	5.24	Filtered through paper.
Aug. 14,	River, ...	0.0051	0.0211	–	–	2.64	3.20	5.84	Unfiltered.
		–	–	0.0051	0.0165	2.64	2.08	4.72	Filtered through paper.

We might consider other localities where the so-called natural filtration is in operation; but these examples will probably suffice to show the main features of the method.

Conclusions.

The so-called method of natural filtration consists in drawing the supply required or obtained from what is known as the ground-water, and is practicable only in localities where the ground-water is of good quality, free from possibility of pollution, and of sufficient depth and extent. The yield of any well, basin, or collecting-gallery is limited, although it may not be possible, by experiments continued for a long time, to fix the exact limit. Although something may be judged from the general lay of the land, yet correct evidence as to the possibility of obtaining a supply of sufficient abundance and of satisfactory quality can be reached only as the result of direct experiment.

The most favorable location of such a well, basin, or gallery is in the neighborhood of a running stream or of a pond or lake. The proportion of water obtained from the land side and from the river or pond near which the collecting-works are situated, varies with the circumstances of each particular situation. Sometimes the amount drawn directly from the stream is practically nothing, and the stream cannot be relied on alone to furnish the necessary supply, unless in exceptional cases where the ground is very pervious, and the current sufficiently rapid to prevent clogging of the bank surface. As far as the character of the water is concerned, it is in New England generally good when sufficiently abundant: it is almost always harder than the river-water, but in most localities in our State this difference in hardness is small although appreciable. In limestone regions, however, the ground-water is often so hard as to be unsuited for use; and sometimes the presence of streaks or beds of clay makes it impossible to obtain clear water. Other substances which are present in the ground may render the water inferior, so that, as a rule, it is necessary to submit it to chemical examination. Wherever experiment shows that this method can furnish a supply of water suitable in respect to quality and quantity, it is to be recommended in preference to artificial filtration.

Further, although there is less liability to pollution than in the case of small shallow wells sunk near dwellings, slaughter-houses, factories, or stables, it must be remembered that the ground-water is fed by the percolation into it of the atmospheric water, and that it is possible to pollute even a large body of water. This fact should be taken into account in choosing a locality for the collecting-wells.

In matters of this kind there is great liability of drawing hasty conclusions from incomplete data, especially in our country where we are in such haste to carry out a work when once actually decided upon, and where there is a disinclination to spend money in investigation before the decision is made. Any such preliminary examination with reference to a future water-supply should involve a careful study of the extent and character of the stratum containing the ground-water which is to be utilized, and the effect of the pumping upon its level. This is readily done by driving iron pipes with perforated "points" at regular distances, preferably in two lines at right angles to each other, intersecting in the experimental well. Observations should be made on the natural level of the ground-water before pumping is begun; and the pumping is best conducted by keeping the level of the water in the well at a certain measured distance below the natural level of the ground-water, or below the level of the water in the pond or stream. Although absolute equilibrium cannot be established for a considerable time, unless the water comes very freely, sufficient indications can be obtained to form judgment, within limits, as to the probable yield of the well. To obtain information as to the character of the water to be obtained, it is much more important to examine the ground-water than the water of the river, although examination of the latter should not be neglected.

It is also important to obtain information as to whether the supply must be drawn mainly from the rain-fall over the region drained by the gathering well, or whether there is sufficient movement to the underground water to practically increase this area. Where the level of the well is not below that of neighboring ponds or streams, it is generally the rainfall alone over the drainage area of the well which furnishes the supply. This admits of being calculated with some

degree of accuracy, if the general character of the land is known. Sometimes higher land, even at a considerable distance, may cause the yield to be greater than calculation would ascribe to the apparent drainage area. In all cases the preliminary examinations should be made by those conversant with the matter, as there is great liability to over-estimate. As a rule, the amount obtained from any such well is greater at first, as it requires time to drain out the water naturally occupying the territory which hereafter is to flow into the well, and in some cases it may be years before the well falls to what may be considered its normal delivery.

III. — Household Filtration.

In localities where there is a public water-supply, it should be the duty of the water board or company to deliver the water to consumers in a condition fit for domestic use.[1] If the source which is, on the whole, the most available for the water-supply is such that filtration is absolutely necessary, the water should be filtered on the large scale by the authority controlling the works. Even taking into account the large amount of water used for extinguishing fires, flushing sewers, watering streets, etc., it would no doubt be cheaper in any given case to filter the entire supply on the large scale than for each consumer to filter with equal thoroughness his individual portion. Even if the expense were equal, or if the filtration on the large scale were more expensive, there would still be objection on sanitary grounds to intrusting the matter to individuals, unless indeed the filters could be arranged in the line of the service-pipes, as gas or water meters are introduced, and be under the control of the water-board. This, in our country, would scarcely be practicable.

While, therefore, a water which needs filtration *ought* not to be regarded in its natural condition as suitable for a general supply, every one knows that few water-supplies come up to the theoretical standard. In the large majority of towns supplied from rivers, the condition of things is as tersely expressed by a superintendent of water-works, in

[1] An exception may be made in respect to the temperature. In our climate it would be too much, at present at any rate, to insist that the water in summer should be as cool as might be desired. Ice is comparatively cheap, and the habit of drinking iced-water is almost universal, and would probably be so still if the water were furnished at any temperature above 45° F.

answer to a circular of inquiry, "When the river is clear we have clear water: when the river is muddy we have muddy water." In such cases, whatever may be the feeling as to the proper authority to effect the filtration, under the existing conditions those who can afford to filter their own supply will be likely to do so if practicable. Another and greater demand for household filtration arises in the cases of detached houses and smaller towns where there is no general supply, and where it is necessary to rely upon wells and cisterns.

For effecting filtration on the household scale, numerous devices have been employed. The records of the Patent Office contain a very great number of filters which have been patented, although to one who is not an adept at discrimination it is difficult in many cases to see any thing but adaptations of old ideas. It would be a hopeless task to undertake any enumeration of the various forms proposed, nor would such an enumeration be of practical value. The materials employed in filtration are also very numerous: many sorts of porous stone, sand, powdered glass, bricks, iron in turnings and other forms, vegetable and animal charcoal, sponge, wool, flannel, cotton, straw, sawdust, excelsior, and wire-gauze, — these are some of the substances which are used. There are certain fundamental and necessary requirements which must be met by a filter suitable for household use. In the first place, the filter must be made of a material which cannot communicate any injurious or offensive quality to the water which passes through it; second, the filter must remove from the water all suspended particles, so as to render the water bright and clear; third, the filter must either be readily cleaned, or the filtering-material must be such as to be readily renewed. In addition to these *requirements*, it is of great advantage if the filter is able to remove a noticeable amount of the dissolved organic matter which most waters contain.

As we have already seen in an earlier portion of this paper, the action of a filter is either mechanical or chemical. There is a mechanical action by virtue of which solid particles which are too large to pass the pores of the filter are arrested: other particles are drawn by a force of adhesion to the surface of the particles of the filter, and are

thus removed. This property of adhesion, if it may be so called, is sometimes exerted to such an extent as to remove substances which seem to be completely dissolved, without, however, producing any apparent chemical change in them. The substances so removed may be again by proper means recovered and brought into solution. There is also an unmistakable chemical action, by virtue of which certain substances are destroyed, or rather converted into new compounds. This action is mainly due to processes of oxidation which take place, in part at the expense of the oxygen which is contained in the solution, and in part at the expense of the oxygen mechanically entangled in the pores of the porous substance employed. Different porous substances differ very much in this respect. While, as we have already seen, clean quartz sand possesses the property to a slight degree, other substances, such as animal charcoal (bone charcoal), possess it to a very great degree.

We may divide the various filters into three classes: first, those of small size, intended to be attached to the faucet, where the water is brought in pipes either from the service-mains of a general supply, or from a tank in the building; second, the portable filters intended to occupy a more or less permanent position, and to be filled with water, either by some ball-cock or other similar arrangement, or by means of smaller supplies continually renewed; third, the more permanent and fixed devices which are inserted or built into underground or other cisterns.

It may be stated on general principles, with reference to the smaller sorts of filters, that, considering the volume of water which must flow through an extremely limited amount of material, no filter capable of being screwed on to an ordinary water-tap can act in any other way than as a strainer. It is not difficult to construct a filter which can be attached to the faucet without very seriously obstructing the flow, and which shall for a limited time remove all floating objects, and render the water clear and free from turbidity.[1] It is safe to say, however, that no such filter has been devised, or is likely to be devised, which can do more than this, — which can in any case free the water from impurities held in

[1] Except in the case of finely divided clay, as already seen: this is difficult to remove even by the carefully conducted filtration of the laboratory.

solution. Moreover, the success of such a filter in the accomplishment of its legitimate work depends upon the frequency with which it is cleaned. No filter can be self-cleaning. Attention on the part of some individual is necessary; and in the household, where such matters are generally left to the care or neglect of servants, the filters are more likely to be neglected than to be cared for. It is true that in the case of some of them the actual clogging of the filter, and the consequent interruption of the usual supply, may enforce attention; but before this happens the accumulated organic matter, vegetable and animal, has begun to decay, and most likely causes the water passing through to become of poorer quality than it would be if left without filtration. In many cases a filter once screwed upon the faucet remains for month after month without being cleansed, so that its presence is simply a delusion and a snare.

Of all the patent contrivances which have been proposed, there is probably, after all, none better than the form which has been in use for many years, which is filled with clean quartz sand, and is capable of being readily reversed and thus cleansed. Even a cotton-flannel bag, primitive and uncouth as it may seem, is very efficient, provided the pressure is not too great: it may be often renewed at a trifling expense, and in summer the odor of the vegetable matter entangled will probably call attention to it, and lead to its frequent washing or renewal. Sponge is very efficient as a strainer, and admits of being compressed into small compass. There are several forms of sponge filters which may be screwed upon a common tap. If the sponge be removed and washed with hot water every few days (every day, in fact, in hot weather), these filters serve a good purpose: left to themselves, however, they do more harm than good. Of course with such a filter the flow of water is more or less obstructed; and, if the arrangement is such as to facilitate removal for cleaning, the temptation is always before the servant to remove the filter altogether in order to obtain the water more freely.[1]

[1] Sponge is much used in filtering water for manufacturing operations, such as paper-making; and has been used to a limited extent in connection with sand and gravel, even on the larger scale of a town supply. Alton, Ill., pumps from the Mississippi River; and the water is, as I am informed by the superintendent, filtered through sponge contained in a cast-iron filter-box of

We come now to the larger forms of filters, to those which are portable, but which are intended to occupy a permanent position in the room, or in some cases to be placed in the tank from which the supply is drawn. The material which, next to simple sand, has probably been used as long as any thing for the purpose, is stone. Some varieties of sandstone are particularly porous, sufficiently so to allow of the use of slabs of the stone as filters: other similar substances, such as pumice-stone or unglazed earthenware, have been employed; the most common arrangement being to insert the stone as a horizontal partition in a small tank or vessel. Here we have to deal in the main with simple mechanical action. As far as I know, these filters are not in common use in this country, although found occasionally.

Without entering into a detailed consideration of the various other materials which have been and are used, we may notice that one of the most common, one which is used and has been used for a long time, is animal charcoal. All varieties of carbon formed by the destructive distillation of vegetable or animal matter possess the property of removing organic matter from solution, but to a very different extent: that prepared by the distillation of bones, by subjecting bones to a high heat in retorts to which the air does not have access, is one of the most powerful, and is on this account produced on a large scale. One of the familiar uses to which it is put in the industrial arts is in the refining of sugar, where it is employed to remove the coloring matter from the crude sirups. There are a great many forms of filter for using animal charcoal, and the material is one which has often been the subject of experiment. In order to ascertain its effect on such waters as Cochituate, which may be regarded as a fair example of the kind of water most used in New England, a number of experiments have been made, most of them with a filter much employed in England, manufactured by the London and General Water Purifying Company. A sectional view and an elevation of one of these filters is

54 cubic feet capacity: this box fits into a tight chamber in the aqueduct leading from the river to the pump-well, and can be raised by machinery. The box can be raised, the sponges renewed, and the box replaced, in three hours. The amount of water filtered is at present only 150,000 gallons a day. When the river is muddy the sponges are cleaned every three or four weeks: sometimes, when the river is clear, not oftener than once in three months.

given in the accompanying illustrations, Figures 12 *a* and 12 *b*. The earthenware filter-box is filled with animal charcoal, in the form of charred bones, broken into small pieces, and freed from dust. There is no chamber for storing filtered water: the water is filtered at the time it is drawn off for use. The filter is readily cleansed and the charcoal renewed. The water passes *upwards* through the filtering-material, in order that matters spontaneously settling down may not be deposited upon the filtering-material, and may not, therefore, help to clog its pores; and, further, that the suspended matters strained from the water, being separated as they always are, mainly at the surface of the filtering-material, may fall away from it and deposit elsewhere; the consequence of this is, that the filtering-material requires less frequent cleansing. This filter may be taken as a type of the better class of filters which contain the charcoal in fragments rather than compressed into blocks. No attempt was made to institute a comparison between this and any other form of filter using the same material: the general arrangement is, however, as good as in any one that has come under my observation.

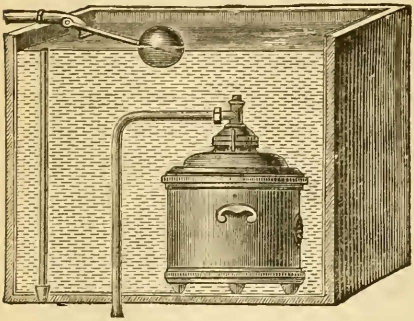


FIG. 12 *a*.

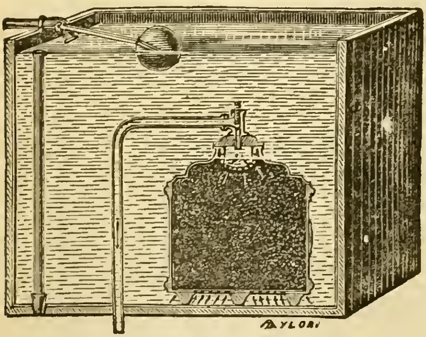


FIG. 12 *b*.

For the present experiments, one of these filters of small size, No. 0, was placed in a tank which is supplied by Cochituate water, and a stream of water was allowed to flow through it at various rates. The results appear in the following table: —

TABLE XI. — *Examination of Filter of Animal Charcoal.*

[Results expressed in parts per 100,000.]

DATE.	Tank Water.		After Filtration through Paper.		After Filtration through Animal Charcoal.		Rate of flow. No. of minutes required for one liter.	Total number of liters passed through filter.
	Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."		
1877.								
November 17,[1]	0.0181	0.0363	0.0173	0.0192	0.0384	0.0176	15	12
19,	0.0043	0.0144	0.0043	0.0139	0.0176	0.0104	45	102
21,	–	–	–	–	0.0040	0.0101	30	196
23,	–	–	–	–	0.0053	0.0088	17	340
24,	–	–	–	–	0.0035	0.0099	7	510
December 8,	0.0040	0.0163	–	–	0.0048	0.0091	9	1,334
18,	0.0053	0.0163	–	–	0.0059	0.0104	17	3,396
29,	0.0045	0.0133	–	–	0.0043	0.0107	5	5,470
1878.								
January 11,	0.0048	0.0149	–	–	0.0048	0.0133	4	9,173
12,	0.0051	0.0157	–	–	0.0037	0.0117	7	9,470
22,	0.0053	0.0139	–	–	0.0053	0.0117	2	10,136
Average of last six,	0.0048	0.0151	–	–	0.0048	0.0111	–	–

[1] Tank disturbed by insertion of filter.

After the examination of Nov. 24, the filter was put into a smaller tank containing water which was strongly colored with extract of peat; after the water had passed for a sufficient length of time through the filter, a sample was subjected to examination with the following results: —

	Amomnia.	"Albuminoid Ammonia."
Water before filtration, ...	0.0416	0.0389
Water after filtration, ...	0.0232	0.0136

The water after filtration was entirely destitute of color. The filter was then replaced in the tank as before; and, a constant stream being allowed to pass through it, the water was examined from time to time with the results indicated in the table, from Dec. 8, 1877, to Jan. 22, 1878.

It thus appears that the bone-charcoal is able to remove a considerable portion of the nitrogeneous organic matter from the water; and these, of course, are but confirmations of the experiments of others. Frankland at one time proposed to filter the whole water-supply of London by this method. Although this would be expensive, it is not altogether impracticable. In large works it would be possible to wash and re-burn the coal from time to time, and the dust and waste would have a certain value as a fertilizer.

I have also made some experiments with bone-coal which had been compressed into blocks. The results were, as a whole, not as favorable as when the charcoal is in lumps. With Cochituate water the effect was about the same, as appears from the results of a number of experiments, the average of which was as follows: —

	Ammonia.	"Albuminoid Ammonia."
Water before filtration, ...	0.0043	0.0144
Water after filtration, ...	0.0033	0.0108

With a strongly colored peaty water, the results were not as satisfactory.

The action of bone-coal in the removal of *mineral* matters in solution is, on the whole, slight, although at first it is appreciable on certain salts: thus a hard water is slightly softened at first. This action, however, soon ceases.

Another material which has lately come into use to a considerable extent in England is what is known as "spongy iron." It was observed a long time ago, that metallic iron possessed the property of removing considerable quantities of organic matter from solutions containing it; and iron in turnings, and in other forms, has been proposed and used to a very limited extent as a means of purifying water. The material at present alluded to, and which forms the essential part of Bischof's Patent Spongy Iron Filter, is an iron which has been reduced from a hematite ore without fusion, and is consequently in a porous and finely-divided condition, and in its effects resembles the carbide of iron before referred to.

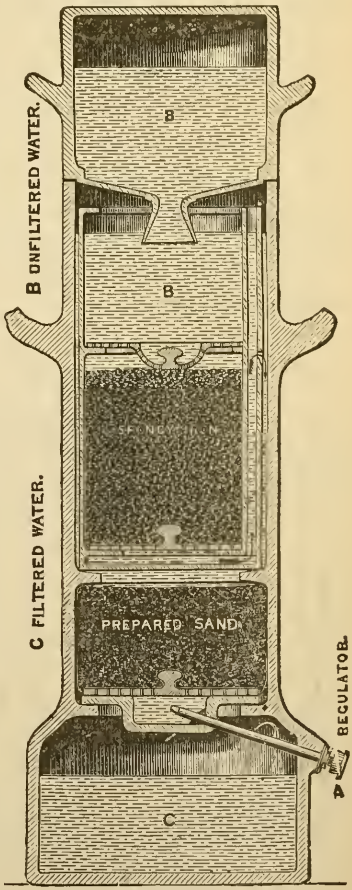


Fig. 13.

The filters are constructed in various forms, but on the same general plan. Fig. 13 represents one form, where the water is supplied from an inverted bottle, which must be refilled as often as empty. In other forms the reservoir of unfiltered water is kept full by being connected with the service-pipe by means of a ball-cock attachment. The material of all the vessels is earthenware.

To ascertain the effect of filtration through spongy iron on one of our soft waters, a small-sized filter of the pattern shown in Fig. 13 was procured, and the filter connected with the Cochituate service-pipe in my laboratory. After running a constant stream of water

through the filter for several days, the water still showed by its color and taste that it carried considerable iron in solution. The water, examined as to the effect produced on the organic matter, gave the results indicated in the accompanying table, Nos. 1, 2, and 3.

After these determinations, the connection with the service-pipe was interrupted, and the filter supplied with a somewhat strongly colored peat-water; after this had passed through the filter sufficiently long to displace all the water which had previously filled the apparatus, specimens of the filtered and unfiltered water were subjected to examination, with the results recorded in the table, as No. 4.

The filter was now brought into connection with the same tank which had supplied the carbon filter, and a continuous stream allowed to flow. When some 1,500 liters had passed through the filter, the water was examined; namely, on Dec. 18, and again on Dec. 29 (Nos. 5 and 6). The filter had now become clogged. The material was after this renewed; and the results, Nos. 7, 8, and 9, represent subsequent determinations.

TABLE XII. — *Examination of Spongy Iron Filter.*

[Results expressed in parts per 100,000.]

Number.	Date.	Before Filtration.		After Filtration.		Rate of flow. No. of minutes required for 1 liter.	Total No. of liters passed through filter since renewal of material.
		Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."		
	1877.						
1	November 23, A.M., .	–	–	0.0064	0.0107		
2	23, P.M., .	–	–	0.0051	0.0112		
3	24, . .	–	–	0.0056	0.0117		
	Average, . . .	0.0050	0.0150	0.0057	0.0112		
4	November 26, . .	0.0381	0.0363	0.0179	0.0171		
5	December 18, . .	0.0053	0.0163	0.0059	0.0109	85	
6	29, . .	0.0045	0.0133	0.0040	0.0115	40	
	1878.						
7	January 11, . .	0.0048	0.0149	0.0064	0.0139	4	576
8	12, . .	0.0051	0.0157	0.0056	0.0115	6	833
9	22, . .	0.0053	0.0139	0.0056	0.0117	16	2,614
	Average of last three,	0.0051	0.0148	0.0059	0.0124		

In judging of the effect produced, it is to be noticed as generally true in the case of this and other filters, that from a water containing a small amount of organic matter, a less *proportion* is removed than from one which is more impure. This is plainly seen in comparing the action of the spongy iron on Cochituate water, and on the peaty water. There is no question but that the spongy iron has a marked action on organic matter, but I found considerable difficulty in obtaining the filtered water free from iron. After a very large amount of water had been passed through the filter, it still retained the color due to the presence of iron. The filters are constructed with a view to the removal of the iron by the subsequent passage of the water through fragments of flint and quartz-sand, with which has been mixed pyrolusite, the native oxide of manganese. My experience seemed to show, that, in order to obtain water reasonably free from iron, it was necessary to fill the reservoir so many times, that, unless it were possible to make connection with some tank or service-pipe, no ordinary individual would have the patience to follow the directions, which are to "fill the filter, and let the water run off until bright and free from taste." As other experimenters have not mentioned this as giving difficulty, I am inclined to think that the cause of the trouble is, that, as is well known, the Cochituate water, like other soft waters, acts violently on iron. Hard water, such as has been used mainly by the Rivers Pollution Commission and by others who have experimented on this material, has probably much less action. I found, on renewing the iron after some six weeks' use, that it was considerably rusted throughout the entire mass: I finally succeeded in obtaining better results, by renewing the iron first, and allowing the water to run for a number of days before renewing the sand; in this way I obtained finally a water nearly free from iron. While the material is certainly one that commends itself to a chemist, and when properly used is capable of exercising a marked effect upon dissolved organic matter, it should be said, that, considering the capacity of the filters, they are quite expensive. Thus the filter experimented with was calculated to yield only nine gallons in 24 hours; the retail price is £1. 10*s.* (about $7.50), and the material for re-charging 2*s.* 9*d.*; while one capable of yielding 24 gallons per day

costs £2. 15s., i.e., about $13, and is somewhat bulky withal. There are also tank-filters on the same principle, and a larger size would probably give somewhat better results than the small-sized one on which my experiments were made.

I have also experimented with the so-called Silicated Carbon filters. The material of these filters is compressed into blocks, and consists of the residue of the distillation of a certain variety of bituminous shale. Thus it is a coke mixed with mineral matter. In the common form of household filters of this make, the block is cemented as a partition into an earthen jar, and is not readily cleaned. Some experiments with an ordinary filter of small size gave the following results: —

	Ammonia.	"Albuminoid Ammonia."
Water before filtration,	0.0043	0.0144
Water after filtration,	0.0035	0.0115
" "	0.0045	0.0120
Water before filtration,	0.0181	0.0363
Water after filtration,	0.0080	0.0128

These results show a considerable action on organic matter; and there is no doubt that the material is effective as a means of purifying water. I find, however, that with the water used, the filter clogged rather rapidly: it would, no doubt, give better results if the water were first passed through sand or other material which could intercept the floating particles. It is true of this as well as of the "Spongy Iron" and other filters, that the smaller sizes would hardly find favor with an American public. The larger sizes which are arranged for automatic supply from a tank, although of course more expensive, would give much greater satisfaction.

As a result of my own examinations and the published results of other experimenters, I am led to the belief that there is no substance, on the whole, better than animal charcoal for household filtration. There are, however, certain points which are to be taken into consideration. The charcoal should be renewed from time to time; how often, will depend upon the character of the water, and the amount

passed through the filter. If the coal be in blocks, the clogging of the pores will indicate the necessity for cleaning; if in granules (which on many accounts is preferable), it may be well to renew the charcoal once in six or twelve months according to the amount of water used. In the case of a filter fixed with some permanence, it would be worth while to have a simple chemical examination if the efficiency of the filter were suspected: this would indicate whether the work was still being properly performed. It is true in the case of these as of filters in general, that unless attention is paid to them, and they are cleaned at proper intervals, their presence is worse than useless.[1]

We come now to the discussion of filters suitable for cisterns or for tanks of considerable size. There is an exaggerated idea, in the minds of many, of the purity and wholesomeness of rain-water. As ordinarily collected from the roofs, and stored in cisterns, rain-water is far from being superior to good spring-water in regions where the natural spring-waters are not too hard. It is a disputed point, whether very soft water is as wholesome as water which by its passage through the earth has taken up some mineral matter. Be this as it may, the collection of water from the roofs of houses involves the collection of dust and dirt more or less objectionable in character, especially in places where soft coal is burned. Although it is possible by automatic contrivances to avoid the collection of the first portions of the water coming at any time from the roof, yet these do not perfectly accomplish their intended object, and are not at all commonly employed. Moreover, the construction of ordinary cisterns is such that after the water is once collected it is liable to deterioration and to contamination by various foreign matters which fall into it. However, even in its ordinary condition cistern-water is apt to be better than well-water, as it is seldom contaminated by sewage in any form: still cistern-water

[1] When water is filtered through animal charcoal, it is better that the filtration should be made as the water is needed for use. I have found the filtered water to keep bright and clear even when exposed to sunlight; but if it be mixed with sugar or some such other organic substance, and exposed to light, it will gradually become turbid: this is explained by the fact that the water in filtering takes up some *phosphates*, and is rendered the more capable of supporting the growth of the lower vegetable organisms if the conditions otherwise be favorable.

should, as a rule, be subjected to filtration before being used for drinking. Most of the materials in common use as filters can be obtained in forms suitable for insertion in ordinary tanks or cisterns, from which the filtered water can be delivered by gravity; and it is not uncommon to construct underground cisterns so that the water is not pumped directly from the cistern, but from a sort of pump-well, to enter which the water must pass through a porous partition-wall made of bricks.[1] These walls are constructed in various ways: one form is represented in the accompanying cut, taken from "Scribner's Monthly Magazine" for September, 1877.

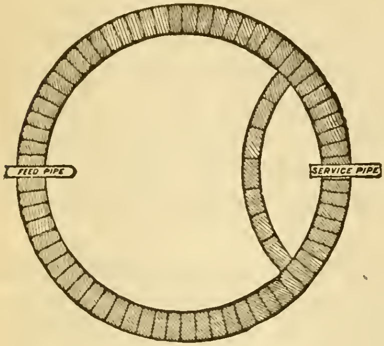


Fig. 14.

When the brick partition is new, it is undoubtedly of good service; but it soon becomes clogged, and covered on the outside with a deposit of organic matter, so that after a time the water which passes through the brick wall must first have an opportunity to leach out what it can from this mass of decaying matter. Fortunately in many cases this clogging so interferes with the passage of water through the wall, that attention is called to the fact, the cistern is cleaned, and the filtering-wall is cleaned or renewed; but where the filtering-surface is large, and the filtered-water chamber of considerable size, the water may be in many cases supplied in sufficient amount long after the process of filtration is an injury rather than a benefit. I have had occasion to examine samples of water from several such cisterns: the results obtained appear in the following table: —

[1] An attempt was made to filter the supply of the village of Malone, N.Y., through a filter of soft brick, but it was not found practicable to filter with sufficient rapidity.

TABLE XIII. — *Examination of Cistern Water filtered through Brick Walls.*

[Results expressed in parts in 100,000.]

Number.	Date.	Description.	Water as Received.		Water after Passing through Paper.		Solid Residue of Water as Received.			Solid Residue of Water after Passing through Paper.			Chlorine.
			Ammonia.	"Albuminoid Ammonia."	Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.	
	1877. April 17,	Unfiltered, .	0.0131	0.0080	0.0131	0.0080	3.96	1.32	5.28	2.68	1.44	4.12	0.32
	April 17,	Filtered, .	0.0125	0.0072	0.0125	0.0064	5.24	1.32	6.56	4.64	1.44	6.08	0.36
323	Sept. 11,	Unfiltered, .	0.0018	0.0115	0.0048	0.0091	2.56	0.68	3.24	1.72	0.52	2.24	0.10
324	Sept. 11.	Filtered, .	0.0243	0.0165	0.0243	0.0128	3.20	1.60	4.80	3.10	1.30	4.40	0.12
340[1]	Sept. 18,	Unfiltered, .	0.0037	0.0117	0.0037	0.0104	–	–	2.44	1.68	0.72	2.40	–
341[1]	Sept. 18,	Filtered, .	0.0083	0.0141	0.0083	0.0126	–	–	4.24	2.92	0.88	3.80	–
460	Dec. 10,	Unfiltered, .	0.0213	0.0067	–	–	3.20	0.28	3.48	–	–	–	0.69
459	Dec. 10,	Filtered, .	0.0072	0.0069	–	–	4.80	0.40	5.20	–	–	–	0.70

[1] Nos. 340 and 341 were from the same cistern as Nos. 323 and 324.

I have also had occasion to examine some of the deposit taken from the surface of such a filtering-wall as has been described. I found it to contain a considerable amount of animal matter in the remains of various insects, worms, etc. Chemical examination showed that it contained 19.8 per cent of organic matter (i.e., loss on ignition), and that it contained 1.11 per cent of nitrogen.

The objection made to the arrangement which has been described is not to the material; for porous brick is efficient in removing suspended matters from water passed through it, and communicates nothing that could be or become injurious. The trouble lies in the fact that the wall soon becomes clogged, and as a rule is not readily accessible. Moreover, when the cistern is relied upon as the sole or as a principal supply for the household, it is impossible to renew frequently the filtering-wall, or even to thoroughly clean the outer surface. The best that can be done under ordinary circumstances is to clean the outer surface of the wall as thoroughly as may be with a stiff brush every few months, and to renew the wall whenever the probability of a rainy season allows.

The filtration in the cistern may, however, be better accomplished in other ways, two of which I will indicate. In the first place, instead of the wall, the filtering-material may be placed in a frame capable of sliding in a groove and of being readily lifted from its place. The filtering-material may consist of porous tiles or of blocks of animal charcoal; and, if duplicate frames are provided, the grooves may be so arranged that a fresh frame can be lowered into place before the old one is taken away. The Figure 15[1] represents a cistern constructed with such frames containing blocks of animal charcoal, as prepared by Atkins & Co., London. These blocks can be readily cleaned by scraping the outer surface (at some expense, to be sure, of the material of the blocks), and they can be renewed when necessary. They are made of various densities; the most dense permitting the passage of 30 to 40 gallons per square foot per day, while the most porous pass some 250 to 300 gallons. For use in ordinary cisterns tolerably porous blocks would probably answer well enough, and for such use as this the charcoal is

[1] Taken by permission from Fanning's Water-Supply Engineering.

more conveniently employed in this form of blocks than as fragments.

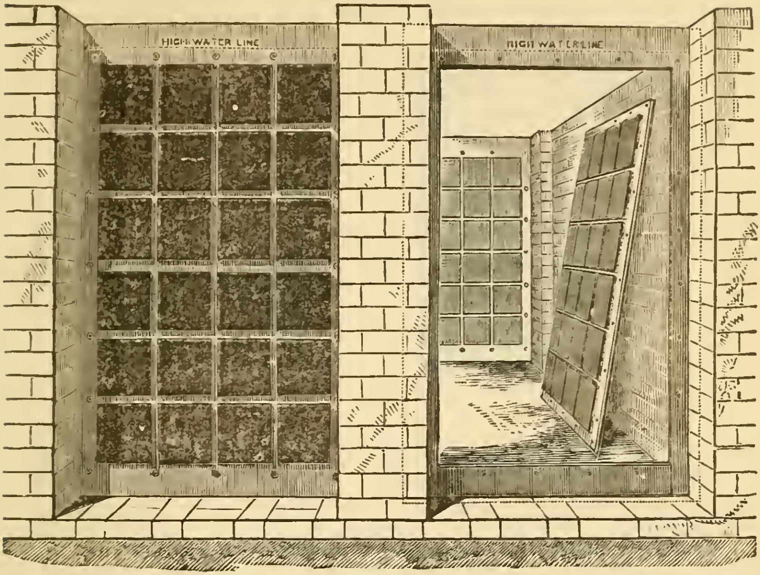


FIG. 15.

The arrangement which has been described is rather expensive for common use; although, if the necessary provision were made in the original plan for the construction of the cistern, it would, on the whole, be more satisfactory than other plans which involve less outlay at the start. Various other methods are in use for employing animal charcoal in cisterns, one of which is represented in the wood-cut.[1]

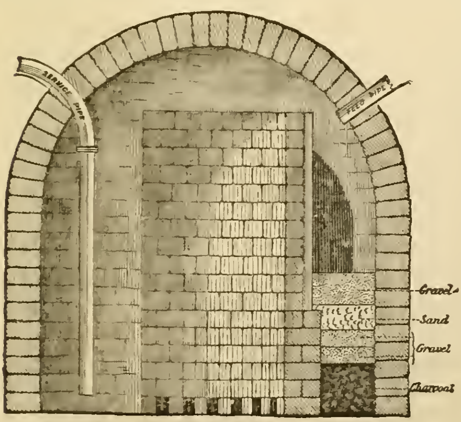


FIG. 16.

This arrangement is open to the common objection, that the difficulty of access throws an obstacle in the way of the renewal of the material as frequently as

[1] This cut is taken from Scribner's Magazine. The writer there speaks of using wood-charcoal: animal charcoal would be more effective.

necessary. A better plan on many accounts is represented in Figs. 17 and 18. Here the box which contains the sand and charcoal is coupled on to the suction-pipe of the pump. The

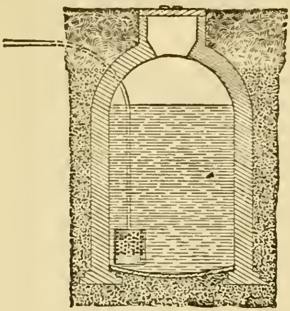


Fig. 17.

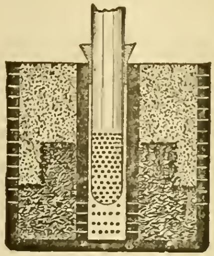


Fig. 18.

box can be removed from time to time, say once a year at least, and the contents renewed. These figures are taken from Bailey Denton's "Sanitary Engineering;" other forms have been devised to accomplish the same object.

Note with Reference to the Methods of Analysis.

The methods of analysis which have been employed in the examinations of the various samples of water, the results of which are recorded in this report, are the same as in previous years. By the "total solid residue," is understood the solid matter which remains when a given amount of the water is evaporated, and the residue dried at 212° F. until further drying causes no further loss of weight. By the "organic and volatile matter," is understood the loss which this residue is found to have suffered where, after being exposed to a low red heat, it is subsequently moistened with water containing carbonic acid, and again dried at 212° F. It is but fair to say that this determination is far from possessing great accuracy. In the case of certain soft waters, like Cochituate, constant results can be obtained, and the loss is nearly all due to the destruction of organic matter; but, in the case of waters containing a considerable quantity of nitrates and chlorides, the loss may be due in great measure to the alteration and volatilization of mineral matter.

The "ammonia" is determined by distilling a measured quantity of the water with carbonate of soda; and the "albuminoid ammonia" is determined by the method of Wanklyn and Chapman, which consists in subjecting the water, which has been freed from ammonia, to distillation in the presence of a strongly alkaline solution of permanganate of potash. Most nitrogeneous substances, under such treatment, give off a portion of their nitrogen, as ammonia. This amount is constant for any one substance, but different organic substances disengage different amounts of

ammonia. The term "albuminoid ammonia" is used because albumen acts in this way, and the substances in ordinary water, which give off ammonia under these conditions, may be regarded in some sense as allied to albumen.

In the experiments on filtration, the determination of "albuminoid ammonia," before and after passage through the filtering medium, affords a ready means of comparing the filtered and unfiltered water, with reference to the organic matter in solution. In the analysis quoted from the Report of the Rivers Pollution Commission, the terms "organic carbon" and "organic nitrogen" are used. These determinations are made by Frankland's method, and are obtained by the combustion of the residue of the evaporation of the water and the determination of the total carbon and nitrogen contained in the organic matter present.

BIBLIOGRAPHY.

The following list contains the titles of the various works alluded to in the preceding pages. It does not claim to be exhaustive, and makes no attempt to include local American reports: —

Belgrand, M. — Les Travaux souterrains de Paris. Études préliminaires. La Seine. Régime de la Pluie, des Sources, des Eaux courantes. Applications à l'Agriculture. 8vo, pp. 612, with atlas. Paris, Dunod, 1875. [Especially chap. vii., Des nappes d'eau souterrains, and chap. xxvi., Du filtrage des eaux, etc.]

Berlin. — Vorarbeiten zu einer zukünftigen Wasserversorgung der Stadt Berlin. Ausgeführt in den Jahren 1868 und 1869 von L. A. Veitmeyer. 8vo, pp. 368, with atlas. Berlin, Reimer, 1871. [Especially pp. 109–130, — experiments on the ground-water in the neighborhood of the Tegeler See.]

Berlin. — Reinigung und Entwässerung Berlins. Berichte über mehrere auf Veranlassung des Magistrats der königl. Haupt- und Residenzstadt Berlin Versuche und Untersuchungen. 12 Hefte, with 3 Anhänge. 8vo. Berlin, Hirschwald, 1870–76. [Especially Heft v., "über die Grundwasserverhältnisse," with a great number of profiles.]

Brooklyn, N. Y. — The Brooklyn Water-Works and Sewers. Prepared and printed by order of the Board of Water Commissioners. 4to, pp. 159, with 59 lith. plates. New York, Van Nostrand, 1867.

Darcy, Henry. — Les fontaines publiques de la ville de Dijon. 4to, pp. 647, with atlas. [Especially Appendix D, Filtrage.]

Denton, J. Bailey. — Sanitary Engineering. 8vo, pp. 429, with many plates. London, Spon, 1877.

Dresden. — Das Wasserwerk der Stadt Dresden erbaut in den Jahren 1871–1874, von B. Salbach. 8vo. In three parts, with atlases containing many plates. Halle, Knapp, 1874–76.

Dupasquier, A. — Des Eaux de Source et des Eaux d'Rivière comparées, etc. 12mo, pp. 414. Paris et Lyon, 1840.

Dupuit, J. — Traité de la Conduite et de la Distribution des Eaux, etc. Suivi de la Description des Filtres naturelles de Toulouse par D'Aubisson. 4to, with atlas. Paris, 1854.

Fanning, J. T. — A Practical Treatise on Water-Supply Engineering, etc. 8vo, pp. 650. New York, Van Nostrand, 1877.

Grahn and Meyer. — Reisebericht einer von Hamburg nach Paris und London ausgesandten Commission über künstliche centrale Sandfiltration zur Wasserversorgung von Städten, und über Filtration in kleinen

Massstabe. Von E. Grahn und F. Andreas Meyer. 8vo, pp. 153. Hamburg, Meissner, 1877. [Especially Anlage 3, "Historische Notizen uber künstliche Filtration im kleineren Massstabe."]

Grahn, E. — Die städtische Wasserversorgung. 3 vols. 8vo. Vol i. Oldenbourg, München, 1877. [Vol i. contains Statistik der städtischen Wasserversorgungen; Beschreibung der Anlagen in Bau und Betrieb. Vols ii. and iii. are not yet published.]

Great Britain. — Sixth Report of the Commissioners appointed in 1868 to inquire into the best Means of Preventing the Pollution of Rivers. Domestic Water-Supply of Great Britain (Parliamentary Document). London, 1874. [Especially Part iii. 6, "On the improvement of potable water by filtration," pp. 216–221.]

Grimaud, de Caux. — Des Eaux publiques, etc. 8vo, pp. 348. Paris. Dezobry, 1863. [Especially chap. xiv., "de la clarification des eaux publiques."]

Halle. — Das Wasserwerk der Stadt Halle, erbaut in den Jahren 1867 und 1868. Von B. Salbach. Folio, with atlas. Halle, Knapp, 1871.

Humber, William. — A Comprehensive Treatise on the Water-Supply of Cities and Towns, etc. Folio, pp. 378, and many plates. London, Crosby, Lockwood, & Co., 1877.

Kirkwood, J. P. — Report on the Filtration of River Waters for the Supply of Cities, as practised in Europe. 4to, pp. 178, with 30 plates. New York, Van Nostrand, 1869.

Munich. — Berichte über die Verhandlungen und die Arbeiten der Commission für Wasserversorgung, Canalisation, und Abfuhr. Erster Bericht, 1874-75; Zweiter Bericht, 1876, und Anhänge, 1877. 4to, with plans and profiles. München, Mühlthaler, 1876, 1877.

Paris. — Assainissement de la Seine. Épuration et Utilisation des Eaux d'Egout. Documents administratifs; Enquête; Annexes. 3 vols. 8vo, with plates. Paris, Gauthier-Villars, 1876.

Schorer, Th. — Lübeck's Trinkwasser, 8vo, pp. 284. Lübeck, Seelig, 1877. [Especially pp. 248–257, describing the deterioration of water by vegetable growth and decay, etc.]

Ward, F. O. — Moyens de créer des sources artificielles d'eau pure pour Bruxelles. 8vo, pp. 106. Bruxelles, Decq, 1853.

Wiebel, Dr. F. — Die Fluss- und Bodenwässer Hamburgs. Chemische Beitrage zur Analyse gewöhnlicher Lauf- Nutz- und Trinkwässer sowie zu der Frage der Wasserversorgung grosser Städte von sanitärem und gewerblichem Standpunkte. 4to, pp. 152. Hamburg, Meissner, 1876.

Reference may be made also to the following papers: —

d'Avigdor, E. H. — Water-works, ancient and modern. Engineering, 1876 and 1877. [Especially vol. xxii. (1876) p. 101.]

Byrne, E. — Experiments on the Removal of Organic and Inorganic Substances in Water. Proceedings Institution of Civil Engineers, xxv. (1867), pp. 544–555, with supplement and discussion xxvii. (1868), p. 1 and folio.

Dresden. — Ground-water. Proc. Inst. Civ. Eng. xxxix. (1874–5) p. 369.

Abstract of a paper by Manck in the Protokolle d. Sächs. Ingenieur-Verein, Sept. 7, 1874.

Dresden Water-works. — Proc. Inst. Civ. Eng. xxxix. (1874–5), p. 383. Abstract of a paper of Salbach's in the Protokolle d. Sächs. Ingenieur-Verein, May 10, 1874.

Grahn. — Zur Wasserversorgung Prags. Journ. für Gasbeleuchtung und Wasserversorgung, xx. (1877), pp. 162 and 299.

Grahn. — Über Klärung und Filtration von Flusswasser. Journ. für Gasbeleuchtung, etc. xx. (1877), pp. 543 and 723.

Kümmel. — Zur Frage der Klärung und Filtration des Wassers. Journ. für Gasb., etc. xx. (1877), pp. 453 and 522.

Salbach. — Apparat zum Messen der Klärung des Wassers. Journ. für Gasb., etc. xx. (1877), p. 545.

v. Weise. — Beitrag zur Kenntniss der Grundwasserströmungen und der Brunnenwasser bei Bonn. Niederrhein. Correspondenzblatt, ii., p. 16.

SANITATION OF PUBLIC SCHOOLS

IN

MASSACHUSETTS.

BY

D. F. LINCOLN, M.D.,

OF BOSTON.

SANITATION OF PUBLIC SCHOOLS.

The title of this paper is nearly the same as that of one prepared by Dr. Winsor for the Report of 1874. The object and scope of the two papers are, however, quite distinct. The earlier article stated the evils resulting from study, or school-work, when excessive or ill directed. The present will set forth certain results of an inquiry into the site, construction, sewerage, drainage, and ventilation of school-houses, — points very briefly mentioned by Dr. Winsor, — and in addition will consider the question of the transmission of contagious diseases by schools. The method of research has been by addressing a circular of inquiries to the medical correspondents of the Board, and to a number of teachers in this State.

One hundred and thirty-one (131) separate replies to the circular have been received, representing about four hundred schools, with about forty thousand scholars, in ninety-nine cities and towns of the State, not including Boston. This number (being one-sixth of the school population) is large enough to give valuable indications, which is all that was desired for our present purpose; a basis for statistics not being required. In addition, fifty-five replies have been received from the Boston schools, which will be reported separately after the rest.

Site.

Questions. — Is the site high, well drained, free from nuisances, sunny, protected from severe weather?

The replies make it clear that the prevailing tendency is to select a high site insufficiently protected. The first four points are answered in the affirmative in 106, 106, 109, and 124 cases; while good protection is affirmed in but 64, and want of protection in 44. The site is low in 16; drainage bad in 18; nuisances exist in 22, some of which are from privies; and defective light is mentioned in four.

In general, less risk is run in building on a high and bleak

site than on one that is low. Exposure to severe weather is undesirable, and it has its dangers; but the greater danger is that which lurks around the spot where moisture lingers on the walls, where the cellar is often wet or damp, where the sun is denied free ingress, and where the drainage of the sinks and privies does not readily pass off. In these points a high ground has evident advantages. But there are exceptions to this: there may be a marshy pool on the top of a hill, and high land may be so constituted, or so stratified, as to be more or less impervious to water (clay, limestone, granite) in the direction it is expected to drain off from the school. How often, too, do we see the privy placed behind the school on slightly rising ground, which must send the drainings towards the building! A gravelly or sandy soil is generally the best suited for natural drainage.

If springs are found when the cellar is dug, the site must be rejected, unless the water can be diverted: it cannot be kept out by simply concreting the floor and walls. The bottom of the cellar ought to be at least three feet above the average level of the water in the soil. If this seems impracticable, let tile-drain be run around the cellar at the depth of its floor, and furnished with a discharge at some lower point. In some cases it will be necessary to place the cellar-floor at or near the ground level, — an obviously effective remedy against ground-water.

"Dryness of the air" is a complaint which is very often made; but it is a slight fault compared with the dampness emanating from floors, walls, and soil, which has been shown by eminent authority to be productive of consumption, catarrh, and rheumatism. The neighborhood of ponds and swamps is therefore to be shunned. Too many trees may be injurious for similar reasons; besides which, they darken the rooms, and make the light unsteady.

As respects a school, all noisy trades or operations, all that pollute the air with smoke, dust, or odor, must be considered nuisances, to be removed or avoided.

Quotations from Correspondents.

"Windows too small; light therefore imperfect."

"One recitation-room into which the sun never comes."

"Stagnant water all around, no drainage, no protection from the weather."

"Located on a street-corner, which is particularly exposed to the keen north wind of winter."

"The yard is a resort for loungers, who commit nuisances around the building, very disagreeable at times."

"The L. schoolhouse would be better adapted to the use of pupils if it were raised up five feet. This raising of the building now would be an expensive operation. It would have saved a great amount of filth and trouble, if the house had been set up higher when it was built."

Ventilation, Heating, and Dryness.

Ventilation was said to be good in fifty-four cases, not good in thirty-nine, fair in eleven; is effected only by doors and windows in twenty-one; ventilators are mentioned as existing in sixteen.

The heating was found unsuitable in but thirteen cases; tolerable in two.

Dampness of walls or floor was noted in but six cases.

A few words may be said here of the methods of ventilation. In the cities, a schoolhouse is now generally built with a supply of flues to carry the foul air from schoolrooms. Much skill and scientific knowledge are often directed to the attainment of this end. But it is the experience of the writer, that the best system yet adopted in schools requires a good deal of watching, and cannot be intrusted to the sole care of a janitor. It is for his interest to appear economical of his coal: he is therefore under a constant temptation to check the outflow of warm air from the rooms, and to limit as much as possible the period of airing-out, which should come daily after school. Good ventilation is an end which cannot be gained without the expenditure of much fuel. Much also depends on the master: a vigorous man will love fresh air, and a man of the book-worm temperament may permit a close and dusty atmosphere.

An open fireplace gives a considerable change of air; not enough, in reality, for a room full of children, but enough to be worth the cost. Very few stoves are of any value as ventilators: those, however, which are built to resemble open fireplaces, and allow a free and abundant passage of air, are excepted from this remark. Fireplaces should never be stopped up, even if disused.

One of the simplest remedies for bad air is to fit a board

under the lower sash, of the breadth of three or four inches only: this shuts out no appreciable amount of light, and raises the sash so that, between its upper part and the lower part of the upper sash, a current of air is admitted in an ascending direction. This is universally applicable, and is extremely useful, though not capable of replacing a complete system of ventilation by tubes.

Quotations from Correspondents.

(School of 270 children, built a few years ago.) "Many are the complaints parents make to the doctor, of their children's colds; and headaches, rheumatisms, and pneumonias are laid to the bad air, and justly. If the nondescript towers and the fancy iron railing on the roof, where it is used for some purpose not manifest to the ordinary mind, and the fret-work over the windows, had not been deemed necessary for outside adornment, possibly the appropriation might have allowed a ventilator in the east half as well as the west."

(A large city.) "In a general investigation several weeks since, preparatory to a report upon the sanitary condition of the schoolhouses, the ventilation of all the rooms used for school purposes was found to be extremely defective. Heating is largely done by means of base-burning stoves, which, unless regulated with the greatest care, throw out gas into the rooms, and in any case heat the rooms very unequally, and are extremely unfavorable to ventilation. In many schoolrooms the air was found so impure that a stay of five or ten minutes would make one desirous of again seeking the open air."

"The means are ample [viz., flues and windows]. The difficulty has always been that teachers cannot be sufficiently impressed with the importance of constant attention to the condition of the atmosphere of the rooms. If feeling uncomfortable, warm, or oppressed with contaminated air, they more usually prefer to open windows, and let in a large volume of cold air, without considering the risks attendant on such a course."

(A high school.) "One room, forty-two feet square, is heated by two registers in the floor, and aired by two ventilators in the wall above them; all four are at one end of the room, consequently there is often a difference of 8° or 10° between the two ends."

"The pupils inhale heated air while their feet are cold, and suffer from heat and col l at the same time."

"This school has been reported to the Board of Health three times to my certain knowledge, and no notice has been taken of it. As soon as they found I meant business, then they called me any thing but a good fellow." [The special complaints relate to bad ventilation, draughts on the scholars, nuisance from cesspool, and stagnant water all around the building.]

"One large iron stove in each room, with a long funnel passing over the children's heads, is any thing but a suitable method of heating a schoolroom."

Cellars.

Questions. — Cellar story or basement: For what purposes used? About how many feet below ground? Wet or damp? What means are used to prevent dampness entering?

Eighteen buildings are reported as having no cellars. It may be well to remark that in such case an air-space of a foot or two ought to be left under the floor, and in moist land this under space should be paved, or even cemented.

As regards the purposes to which a basement or cellar may be applied, some remarks will be made under the next question. It is a good plan to use a part of the space for play-rooms in bad weather, flooring with hard stone or face-brick to avoid the dust which comes from softer materials. The purity of the air that supplies furnaces must be anxiously guarded from contamination through water-closets, rubbish-heaps, &c. A *laboratory* is reported in one instance: this is an unfortunate location for a useful but odorous department, which ought in all cases to be either in a separate building or in the upper story.

No schoolroom should be even partially under ground. This fault is reported as occurring in only five cases.

Dampness is complained of in twenty-one cases. This is a larger number than one would expect, in view of the preference of high sites for building. If a basement or cellar is to be used for play-rooms, dampness is certainly an inexcusable fault. Some of the requisites for good drainage have been mentioned; but in addition, if a cellar-room is to be used for play, the floor and walls should be cemented. An excellent device for floors, lately introduced, consists in damp-proof layers of asphalt and cement in both the floors and walls.

The following extracts from replies of correspondents represent respectively a slight and a bad case of the faults which occur in cellars.

"Play-room, drink-room, closets (one for each sex, with 12 pans each), and furnaces. Tendency to moisture. Some odor in immediate vicinity of water-closets, which are ventilated by windows and connected with sewers." [Cellar five feet below ground.]

"The cellar is nine feet below ground. Part is used for an evening school, part for the steam-boiler and privies. It is not particularly damp in the part devoted to the latter uses, where there is a cement floor of moderate quality. Under the floor of the room used for the evening

school there are joists laid in what is mostly sand, though purporting to be cement; the floor was recently heaved up here with dampness, and the sheathing is decayed near the floor."

Water-Closets, etc.

Questions. — Are there any water-closets? How many, and on what stories? Of what sort? How ventilated? Do they connect with cesspools, or with sewers? Are there any earth-closets? If so, are they satisfactory? If there are privies, please describe their construction and situation. Are they properly emptied and disinfected? Are there proper provisions for both sexes? Are the children exposed to the weather in visiting them? Are the water-closets, cesspools, or privies sources of offensive odors?

A water-closet is a contrivance for disposing of fæcal matter by "water-carriage," in distinction from the privy or dry-removal system. It usually is found in our schools to be (1) a pan-closet, with a handle, which when raised empties the pan, and lets in fresh water; or (2) a hopper-closet, without the pan, and often provided with automatic apparatus for discharging water into the hopper; or (3) a simple trough of masonry and cement, filled with water, which is frequently renewed. These are the chief varieties. The latter kind has lately been introduced into many large schools, and in some cases it is certainly free from objections. It must, however, be placed in the cellar or basement, in order to prevent freezing; and it is evident that in such a situation it may become a dangerous nuisance. To insure protection, it must be built of masonry cemented, and must slope gently towards the outlet: there should be about it as little wood-work as possible to absorb urine; and the water should be abundant, and changed every day with a good flushing afterwards. The sides should be cleansed at the same time with a jet of water. The space under the seats should be ventilated by a large pipe or pipes led to a flue which does not communicate with the rooms, and which opens above the roof, far from windows: the flue ought to be provided with some means of securing a draught, either by heat or otherwise. It would be proper to lead such pipes to the common chimney, if we could be sure of a fire there all the school-year; but such chimneys often communicate with rooms by fire-

places or ventilators, and, during the month or two when fires are not kept up, it is unsafe to have such an open connection between the vault and the schoolrooms.

The cellar, also, should be watched, and a constant change of air obtained by opening windows according to the weather. There are two reasons why bad air in cellars is specially dangerous to the inmates of schools: (1) because the furnaces are often supplied in part with air from the cellar, which is breathed the next minute in the schoolroom, the air-tube often having a slide expressly intended to admit cellar air, and, even when this bad custom is not observed, the joints of the wooden tube being very apt to be loose; (2) because, independently of this, air has a strong tendency to rise from the bottom to the top of a house, passing rapidly even through floors and ceilings, so that cellar influences are nearly sure to be felt in the rooms.

The importance of observing very great care is shown by comparing the two following reports, taken from schools in the same city, and apparently provided with a similar water-closet arrangement in the basement: —

(A city school of 400 pupils.) "A series of closets over long trenches, in which water is always standing; flushed twice a week; ventilated by a six-inch pipe, some distance to chimney. The odors are sometimes perceived in the various rooms of the building."

Another school in the same city reports: "Cemented bottom, partly filled with water, which is changed entirely every day in summer, and three times a week in winter. Ventilated by a shaft connecting with top of building. *No offensive odor*," — partly because the scouring is more frequent than in the other case, but also because "the greatest care is taken to prevent odors from rising, by a thorough ventilation of the basement."

As regards the other forms (pan and hopper closets), there are certain faults to be spoken of. A pan-closet presents many surfaces on which the discharges can collect: the stream of water is often too weak even to clear out the visible accumulations, and in some cases altogether fails to reach those at the back of the pan, &c.; so that, if not washed, it is apt to be offensive. The chief objection to the pan-closet, however, arises from the small chamber of foul air between the pan and the trap below it. A hopper-closet need not be open to this objection, provided the jet is *abundant and well directed*. One or two of these may be placed, if desired, in

each story and in the cellar, but each ought to have its window opening to the outer air.

For perfect ventilation of such places, nothing is better than a tube, leading to the chimney or open air, or one in the lower part of which (at a height of, say, three feet from the floor) a gas-jet is kept burning, giving rise to a current upwards: the gas may be made useful for light by inserting a pane of glass in the side of the tube. It may be well to add, that *wooden* tubes, traversing several stories, assist the spread of fire in a building.

Many schools, including some in country towns, report the presence of small water-closets in the first or second stories. If care be taken that these are well aired and cleansed, they are not objectionable, but positively desirable, in these situations. There is no doubt that girls especially require some such accommodation, as in a large class there will always be some who ought not to be exposed to the weather, nor to be forced to go up and down stairs unnecessarily.

In some schools, water-closets, apparently of the pan variety, are placed in the cellar, in number sufficient for the wants of the whole school. These will require at least as much watching as the water-vault closets above described. In planning a cellar, all such conveniences should be placed in an apartment strictly separate from that containing the furnace or the play-room, and should have access by windows to the outer air.

The necessity of interposing some obstacle to the rise of gas from sewers, through soil-pipes, into houses, has become generally known to the public. An S-shaped bend in the pipe, if placed in a proper situation, and if the soil-pipe is properly ventilated, will answer the purpose: there are various other contrivances, all equivalent to simple reservoirs of water, placed so as to intercept upward currents of gas, which need not be described here. But, whatever be the arrangements for trapping individual basins or closets in upper stories, it is essential that the main soil-pipe should be trapped before it leaves the building, at a low point, i.e., in the cellar. All soil-pipes should be easily accessible, should be in plain view or protected by simple removable wooden boxing, through their entire course. If enclosed behind lath and plaster, or sealed up under a cement floor,

their defects cannot be discovered without great trouble and expense. The best plumbing in the best-built houses is extremely liable to injury from slight settling of foundations, from corrosion, frost, or rats; and injury to health may result, before any strong odor is detected.

An earth-closet consists of a portable box, with a lid like that of a common water-closet, and worked by a handle in a similar way, only that the pulling of the handle throws a quantity of powdered and dried earth over the deposited matter, instead of sending a jet of water. The earth absorbs the odor in a nearly perfect manner, if it be well dried and powdered; sand will not answer the purpose; charcoal in powder is the best of all. No disinfectant is needed. The apparatus can be safely used in the house, when water-closets are not practicable: it is reported as giving satisfaction by two of the correspondents, but always requires a great deal of care in its management, in order to prevent the occurrence of bad odors.

A privy is a non-portable arrangement, in which the fæces are not deposited in water, but in a vault or other excavation, or on the natural surface of the ground. The privy can never be approved as wholesome; it is capable of injuring the health in many ways. In the commonest form in which it occurs in our country schools, the filth is either thrown upon the surface of the ground, in which case the person is dangerously exposed to cold air; or it is thrown into a pit, where it accumulates usually for a year at a time. A cheap, convenient, and wholesome substitute for this familiar nuisance is to be found in the "pail-closet," as described in the Report of the State Board of Health for 1876, p. 182, in which a pail made of half of a kerosene-oil barrel is placed under each seat, and the contents removed every week for a fertilizer. At the bottom of the pails a layer of ashes, or of dry earth pulverized, is first laid; and a sufficient amount, say a pint or more, of the same should be thrown in after each time of use, taking some little pains to cover up all deposits. Of the present usual form of privy, we quote the following from pp. 184, 185, of the report already referred to.

"It may be said that the simplest and cheapest of those privies, one much in use in the small country towns, involves the minimum of annoyance and risk, since whatever fæcal

accumulation occurs is all on the surface, and is in such free communication with the outer air as to be rapidly dried and disinfected. But at the best it pollutes the soil beneath more than is suspected. It is not cleared out one-tenth as often as is needed, and it exposes those who use it to the inclemencies of the weather to a dangerous extent."

Privies upon the pail-system, properly cared for, need no other disinfectant than that here mentioned, viz., dry earth or fine ashes, except perhaps in the hot weather of midsummer. Privies of the old-fashioned country sort cannot be properly disinfected; for the greater part of all their contents will soak in and contaminate the soil to an indefinite extent, sometimes to a distance of many rods, — in one case, filth was traced in the soil for a distance of nearly a mile. No well in their vicinity is safe. In the present Report of this Board, under Health of Towns, an instance is given where a well used for drinking was located under a schoolhouse, at a distance of thirty-five feet from privies: a chemical examination showed the presence of unchanged excrement in the water of the well. Even a vault of masonry is not always free from cracks, nor are its imperfections likely to be discovered while it is in use as a privy.

To the question, "Are they properly emptied and disinfected?" a negative was returned in fourteen cases; in one instance the correspondent seems to have mistaken the question, and replies, "They empty into sandy soil a few feet below surface." This form of "emptying" the contents is, in reality, the usual one in all country places. The impression seems almost universal, that the earth destroys all poisonous matter as soon as it soaks in; an impression which is practically and most dangerously false. The greater number state that they are emptied once a year; and this seems to be thought often enough. One-fourth of the whole number, however, state the arrangements are "the source of offensive odors;" and no one can doubt that this is an understatement of the fact.

A privy under the same roof that shelters the school ought not to exist for a moment. It is true that delicate children ought to be spared exposure; it is true that the fear of exposure in winter, or a natural shrinking from the foulness of ill-kept privies, leads many little children to conceal

their natural wants, to their bodily harm. But provision for such cases can be made in small country schools by the earth-closet; in large schools there should be a few water-closets, and the main out-house, when there is one, should communicate with the school by a dry covered way. Most children will require to visit the place once in the school-day, and it is not right to turn them out of doors in all weathers for the purpose. This point is almost universally neglected.

In only four cases is it reported that the boys and girls have to use the same privy. It is desirable to take certain precautions in this matter: there ought to be two buildings, and not one divided by boards into two parts; a board fence should separate the two sexes in going and coming; and, where present arrangements are bad, the boys should have their recess at a different time from the girls. To insure decency, and to check immorality, a trustworthy monitor might be appointed not only for recess, but to accompany every child who goes out during school-hours.

Quotations from Correspondents.

From Five Cities.

(School of 525 pupils.) "Privy emptied once a year. Water-closets in cellar, only ventilated by windows."

"Privies never emptied and disinfected."

(A grammar school.) "Vaults emptied once in three years; no nuisance, no apparent need of disinfection; occasional odor from cesspool in yard."

"Generally, I think the city schools are inadequately ventilated, imperfectly heated, with radically defective privy accommodations."

(A primary school.) "The exposure and bad odor keep many children from going when they ought to go. How much this has to do in the causation of disease, I am unable to say."

"To those who use the privies, they are too frequently offensive, from carelessness of janitors."

"Privy out of doors; built of brick, with large vault, most of the time full of water, so leaky that for the last twenty years it has never been properly emptied, disinfected, or ventilated."

From Towns.

(A large and important town.) "We have only one school in the town which I could pronounce free from the danger of offensive odors: the other schools do more or less produce them."

"All through the warm weather an offensive odor pervades the whole building, especially if the wind is from that direction. Privies twenty or thirty feet in rear."

"The vaults are capacious, and I think several years since were cleaned out."

"The building has a cemented brick vault nearly four feet deep; a very objectionable arrangement, and difficult to clear out."

A *large* receptacle may serve as an excuse to neglect frequent cleanings; and the absence of an outlet, and of a water-supply to flush the vault, would make any such structure objectionable. Storage of fæces in a concentrated form must be an evil: otherwise cement and brick are certainly desirable elements in the structure. The vaults of another school, described as "inclined, with a drain-pipe from one corner of the schoolhouse entering the upper end, so that each rain washes the vault," and of still another, in which the "water from a large reservoir can be discharged through the vaults weekly, carrying the contents into a sewer," deserve credit for doing what may perhaps be the best thing attainable under the circumstances, but which should nevertheless be utterly condemned as unsuitable substitutes for direct flow into the sewers.

In a school for one hundred children, there are two privies (and no water-closets) in the cellar; "the solid matter is carried into a cesspool forty feet from the building, by water from roof and from sinks in cellar." Such a water-supply would naturally be uncertain; we should expect to find, as is stated, that the privies are "not in good condition at time of examination, and the means employed for removing contents does not appear to work at all times efficiently;" and, although there are no odors detected in the schoolrooms, the house cannot be regarded as safe in its present state. The absence of urinals for boys is noted.

(School of 82 children.) "A double privy stands four feet from main building; no vault: excrement falls directly on the ground; never cleansed or disinfected; an apartment is supposed to be allotted to each sex, but there is nothing to show which is for each. Children exposed to weather in visiting them. Offensive odors. Primary schoolroom is next to privy."

"The scholars are exposed to the drippings from the eaves of the school-house, which makes the sloping ground dangerously slippery in winter."

"All our privies are about as filthy as possible."

"The privies are near to the building, and of the *worst possible* construction, and in the worst possible condition. No kind of regard has been paid to cleanliness or decency in any of them. In my opinion, the greatest desideratum in our schoolhouses is more air space *per*

capita, — a system of ventilation, — and an organized system of care for the *privies.*"

(A high school.) "Four sets of privies, five holes in each set, with one cesspool; they are without doors, and are all in the cellar, and abut on each side of the central partition, those on one side being for boys, and on the other for girls. Not properly emptied and disinfected. *Decidedly* offensive odors." [This statement of the master is emphasized by the medical reporter, who says that the air of the second-story rooms is contaminated by the privies; "a state of things infernal in its origin and its character."]

"Privies in an addition to building. Entrance through the basement. Good care is taken in emptying them. All the care possible is taken to prevent any injury to health from this source in our schools; but where privies are connected with the basement, where the furnaces are situated, I have no doubt the air becomes more or less poisoned. I have in my building to keep the basement-windows open, in the coldest weather, to prevent this. A very little neglect might cause much evil."

A primary school for 108 pupils has privies "on the lower side of the basement near the wall; the basement-windows are kept open in summer, but in winter they are closed, and there is a bad smell."

(School of 268 pupils.) "The boys have the habit of using the floor instead of the seats."

"There are four open privies, two in the upper story, and two in the lower, poorly ventilated, and not connected with sewer. They are situated just in the rear of the schoolrooms, and open from them; are not in any way properly cleansed, and reek with foul odors, which penetrate the schoolrooms when the doors are opened. They open directly from the recitation-rooms."

In another (high) school in the same town, "the privies were surrounded by, and floors covered with, fæces in all stages of decay and rottenness, which the teacher endeavored to excuse by laying the blame on the janitor."

Ill Effects on Health.

Questions. — Do you attribute to exposed or ill-managed privies any ill effects on the health of the pupils? If so, what?

A very large number reply in the negative, — 82 in all. Some of these are careful to confine their statement to their own schools, admitting the possibility of injury in other cases; a *very* few claim that no evil has resulted, simply because their privies are kept in perfect order; while some express surprise that harm has not occurred.

One negative comes from the school where the privies open directly from the schoolrooms, — the quotation last given. Yet no one could hesitate in pronouncing the state

of things there existent extremely dangerous. But no case of disease had actually been traced to that cause, at the time; and the amount of simple ordinary debility caused by a slowly-acting cause is often very hard to estimate, when one meets the subjects of it as constantly as the master of a school does his pupils.

That such debility may be produced by ordinary "stinks," by living in an air containing fæcal odors simply, is certain; and from this debility up to the production of headaches with slight fever, or of violent, even rapidly fatal cases, of typhoid, there are all possible gradations. Yet the danger lies often far more in that which is not offensive, — in the air which contains sewer-gas, hardly noticed by many; in the sparkling water which pleasantly disguises the dose of liquid ordure which the pupil takes daily at twelve o'clock.

The connection of diphtheria, scarlatina, dysentery, and diarrhœa, with foul odors and bad drains, is now admitted to be a fact, though not always a traceable one. The views given in the following quotations need not be qualified.

Quotations from Replies.

"Catarrhal diseases of the respiratory and digestive organs [through exposure to cold]. I am convinced that dysentery has sometimes been due to exposure in such filthy privies as that alluded to; and, although I can give no instance in which I can say with absolute certainty that typhoid can be traced to these privies, I know that there have been more cases of that disease among the scholars and in the neighborhood of the school this fall than for several seasons past."

"I think it tends to lessen the activity of pupils, brings on indigestion and debility, sometimes typhoid fever."

"I think I have seen the vitality of children so lowered that they did not as readily resist the effects of exposure."

"I have observed more prevalence of scarlatina in those districts where little or no care was given to such cleanliness; and I have a conviction that diseases, especially those termed zymotic, are aggravated by exposure to the poison of foul privies."

"In one instance there are two unsealed vaults, eight feet square, on sandy soil, both within thirty-five feet of the well. Two fatal cases of diphtheria occurred during the past summer among the pupils attending the school to which exception is here taken. It is not presumed to take the responsibility of saying that these cases were caused by this means; but the cases did occur, and there are the vaults within thirty-five feet of the well supplying the pupils with water."

"I do not in this school. I am convinced, however, that we have had

several cases of typhoid fever, as the result of poorly-constructed privies connected with other buildings. These same schools are often troubled with *bad odors*."

"I have attributed many of the low continued fevers which we have to treat amongst school-children, in a great measure to this cause; that it is often the channel through which the germs of scarlatina, measles, whooping-cough, &c., are conveyed to our school-children."

"The presence of diphtheria in school led the conservators of the health of the children to look more carefully to the sanitary condition of our premises: hence the change in the construction of our privies. I leave it for others to draw their inferences. The same cause [viz., total neglect] has been in operation for twenty years, with no appearance of the above disease until now." [It is very characteristic of the production of zymotic disease, that the nuisance often exists for a long period before the outbreak comes; and the fact that a nuisance prevails twenty years without causing specific disease does not insure against an outbreak in the twenty-first year.]

Contagious Diseases.

Questions. — What is your experience in respect to the spread of contagious disease in schools, and the remedies or means of prevention? What is your *opinion* as to such prevention and the means to it?

There is very little real discrepancy of opinion in the replies. With scarcely an exception, all acknowledge the danger of contagion to be real; although a number (fifteen) say that the school or the town they represent has never been troubled with the spread of contagion in and through the school, or that the town itself is remarkably free from epidemics. In the quotations to follow (thirty-three in number), almost every one expresses a conviction that the contagious diseases *have been spread* through the agency of their schools; and, in addition, fifteen other towns have expressed the same belief, but are not here quoted. Of the rest, the larger number refrain from expressions of opinion.

From the care taken in most of the replies, it is evident that the question has been regarded as important. In general, the preventive measures suggested are practically similar: they include dismissal of the affected child, his retention at home (for a period which is stated in only one or two cases); disinfection of clothing and room or house; disinfection of schoolhouse on the appearance of a contagious disease in a scholar; ventilation and cleanliness; the refer-

ence of the matter to a physician in each case; entire isolation of patient; exclusion of neighbors or other visitors during sickness; exclusion from school of the entire family when one member is attacked; suspension of the school; a medical man upon the Board of Selectmen; better statute regulations defining duties of Boards. The extracts give a fair view of the relative frequency of these views.

Extracts from Replies.

"During the prevalence of an epidemic of diphtheria, facts seemed to indicate that it was transmitted by members of families where it prevailed being allowed to attend school."

"Scarlatina, diphtheria, and whooping-cough have been communicated at school. No precaution has been taken against this, except to keep at home children of a family where there is a case of the first two diseases. This rule is not always observed. I think that in a town of our size (Hingham) the spread of contagious diseases can be materially checked by such means."

"All but one school with two departments were closed a year or two ago, to prevent the spread of diphtheria."

"Scarlet fever, measles, and whooping-cough have spread through the medium of schools in this town."

"Whooping-cough has been widely spread by means of the schools, often infecting more than half the scholars of one school. This seems well-nigh impossible to prevent, as it is hard to distinguish the disease, certainly in its early stage. I have known a few instances of scarlet-fever being caught at school."

"I *know* that whooping-cough and measles are often spread in schools here, and have no doubt that scarlet fever sometimes spreads thus. The same may at any time be true of diphtheria. As to *quarantine* for pupils convalescing, or coming from infected families, we have not the requisite uniformity and formality."

"My belief is that there are not proper precautions observed. In one notable instance, pupils went from one school (at which some of the scholars had been taken with scarlatina) to another school, carrying the infection with them, and breaking up the school, themselves suffering with the others."

"I have known epidemics apparently propagated from school as a centre many times. No precaution has ever been taken, to my knowledge, by any of our school or town authorities, in regard to preventing the transmission of contagious diseases. Scholars are allowed to attend school frequently as soon as they are able to get out of doors after scarlet-fever, measles, diphtheria, &c. No regulation as to vaccination is ever enforced. Have known cases where a large majority of the scholars in a school have had scarlatina during a term, all directly traceable to one case imported from Lowell."

"Have seen them spread rapidly when the sessions have kept up; but have seen them controlled by dismissing the schools, and isolating individual cases."

"The two diseases which in epidemic form are most likely to seriously reduce the attendance in the public schools are measles and scarlet fever; and in this respect it seems to me that the effects of the former disease are often more marked than those of the latter. I think that very many of those children who are seized with either of these diseases while attending school regularly would still have them, even if they were kept at home."

"Contagious diseases are not known to have been spread among our school-children except by the agency of cases so slight as not to come under the observation of any physician; and the only available means of prevention seem to be the exclusion from school of all infected persons, and members of their families."

"I think I have known children to have serious preliminary symptoms of both the former diseases [diphtheria and German measles] while yet in school, — fever, headache, dizziness, sore throat, swollen tonsils, nausea, chills, &c., during the last day of school attendance, — and then follows a very serious, perhaps fatal illness, but without, as far as traced, any obvious dissemination of the disease in school."

"The milder contagious diseases are of course spread in the schools, and cases are not wanting where scarlet fever and diphtheria have been communicated. It is some years since either of the last-named diseases has been any thing like prevalent here, — cases being few and for the most part isolated. The school board have full and sufficient regulations in regard to contagion, and enforce them as far as they are able."

"That contagious diseases do spread from scholar to scholar; that so-called intelligent parents do not withdraw pupils from school when they know, or ought to know, that they are liable to transmit disease; that, if teachers exclude, they frequently act injudiciously, being obliged, commonly, to be guided by hearsay evidence, and frequently receiving such information only after the mischief has been done; that physicians do not do their duty in the matter, for fear, I assume, of *giving offence* to patrons; that Boards of Health, in the different cities, should be *required*, and their duties in the presence of contagions as *definitely fixed as possible by State law.* 'What is everybody's business is nobody's.' At the present time children are dying by the dozen, in Haverhill, of diphtheria; and I am not aware that any concerted action is even projected in reference to checking the spread of the disease."

"I have no doubt that diseases are spread from schools in many instances, and oftentimes when the contagion or source of contagion is not suspected. It is my belief that such spread may be very greatly diminished by the adoption of suitable measures by health officers and committees. Public sentiment on the subject should be enlightened; and a just appreciation of the danger from this source would make the adoption of preventive measures an easy matter."

"The ordinary diseases of children usually go through our schools when once they have entered. We take no precautions against the spread of

the same; do not allow pupils from the families where sick of small-pox to remain in school."

"If thorough ventilation, pure water, proper disinfection of vaults, and removal of their contents, could be secured, a great point would be gained toward the disappearance from our schools of these diseases."

"Most imperative needs are clean bodies, clean clothes, and proper ventilation."

"Do not think they spread from schools to any great extent. Where a scholar is taken sick with a contagious disease, the other children of the family are immediately taken from school. Many other parents, through wholesome fear, keep their children at home; and it is not uncommon for a school to be temporarily suspended before many children become sick. I think these means are efficient in preventing the spread of contagious diseases in schools."

"I think there can be no question as to the propriety of closing the schools at once, as it is difficult to enforce any precautionary means among children, owing to the general apathy of parents concerning such matters."

"No sick child should be allowed to go to school until it is ascertained whether it has a contagious disease; and, if so, all children exposed should be kept away from school two or three weeks, and the sick for two or three weeks after recovery."

"Clearly, *every* known means should be employed, — cut off *all* possible communication with school by family attending school, by neighboring children visiting infected family, by *any* person visiting the family, by calls from teacher to house, and all such means."

"That they spread rapidly in schools; and that, whenever they make their appearance in any serious degree, — and scarlet fever and diphtheria are always serious, — the only thing that promises any benefit is their suspension."

"When such diseases appear in one of our schools, it is usually stopped by the committee, though usually not in season to prevent spreading."

"Upon the appearance of any suspicious symptoms, competent medical advice should be furnished at public cost (notice being given by teacher or parent), and strictly followed. The committee is usually negligent in such cases, and seldom capable of deciding in regard to the exigency: therefore a medical opinion is indispensable."

"Take a sick child home, and send for the doctor. Don't scare the rest to death, without the above doctor thinks it wise."

"Our regulation might be made more effectual if teachers had immediate knowledge of the existence of the disease. I think physicians should be required by law to report such cases to the proper authorities."

"The matter should have responsible, paid, medical attention, of such character as to insure the education therein of teachers, doctors, and parents."

"Our Board of Selectmen constitute the Board of Health; and I would respectfully suggest the importance, the necessity, of having one or more regular physicians on the Board of Health of every town."

"Neither they nor their brothers or sisters should be allowed to attend

school again till all evidence of disease has passed away, and both they and their clothing and houses have been properly disinfected and cleansed. If necessary, in times of epidemics, have physicians to examine the schools daily, or close the schools altogether. Probably no means could be enforced that would prove absolutely protective."

"Every town should have a Board of Health distinct from its Selectmen, one member of which should be a physician; and this Board should study to maintain cordial relations with the teachers and with physicians in town. They should hold *stated meetings*, at which reports should be made, and should report yearly to their towns, and to the State Board of Health. During epidemics or in case of prevalence of disease in any house or small neighborhood, it would be desirable (and I think not impracticable) that attending physicians should report to the local board the convalescence of school-children, and the sanitary condition of premises, including disinfection."

"The statutes should limit the number of the Board of Health to *three* in towns having less than ten thousand inhabitants."

"In cases where small-pox prevails in the city, a daily report is made to me by the truant-officer, and all exposed pupils are removed. The house is fumigated every night."

Boston Schools.

The courteous action of the School Committee, in sending the circular upon which this paper is based to the heads of all school districts under their charge, has brought together a considerable amount of information. Fifty-five replies have been sent in, accounting for nearly all the school-buildings. The total number of buildings used for schools within the limits of the city is 159, containing at the present time 49,423 pupils, with an estimated population of 353,000.

The character of these replies is not very strikingly different from that of the others. A very few sites are spoken of as damp, or low, or unhealthy. Dampness of cellars is mentioned in six replies, and in three of these it is also stated that the cellar is used occasionally for a play-room; this, it should be remarked, is a possible source of illness. The construction of many of the privies is of the old-fashioned sort; but as a rule they discharge into a sewer, and in most cases can be flushed either by showers or by the Cochituate water. There is a great deal of complaint, of course, as regards the odors. Twenty-three replies state the existence of offence from this source, or, in some cases, from urinals.

As in the case of country towns, very few attribute direct injury to the health of pupils, to this species of nuisance; a

few, however, complain in strong terms. The City Board of Health in 1876 said, —

"The old-fashioned vaults of a century ago are still in use,[1] and are made to accommodate the several hundred pupils attending each school."

And the writer is informed by them that the state of things has not changed much.

The Board continue in saying that, —

"All vaults of this character, either public or private, are invariably a nuisance. They should be abolished, and water-closets instituted wherever the drainage will permit. At the request of teachers and others, we have made a thorough examination of a large number of these privies, and found them to be extremely offensive, not only to the teachers and scholars, but to the residents in their vicinity. The odors escaping from them pervade the schoolrooms, causing nausea, compelling the teachers to close the doors and windows, to exclude the disgusting scent which even then penetrates the rooms, especially when the atmosphere is warm and muggy, and the scholars are most in need of pure air from without."

Large schools in the suburbs, not connecting with sewers, require peculiar care in this respect; their privies should either be on the pail system, or should have tight vaults, with dry earth or ashes at the bottom, cleaned out every week.

The ventilation is more or less complained of by nineteen. A few lay emphasis on this point, and on personal cleanliness, as important means of checking contagious disease; and this view is certainly correct to a considerable extent. A vast deal depends on the personal character of a teacher, his or her neatness of person and habits, and tact in suggesting improvement to the pupils; and a most important field of effort is properly suggested by one writer, in visiting at the scholars' homes, both for this purpose and to relieve actual deficiency of clothing.

The danger from contagious diseases is not thought considerable, under present circumstances, by most of the respondents, inasmuch as careful regulation and control over that matter have been instituted by the School Committee.

Extracts from Replies.

"Walls are cement on outside. Sometimes rain comes through."

"None of the schoolrooms (primary) are sufficiently exposed to the sun."

[1] This remark is not intended to apply to all the schools.

"The cellar story is used for play in stormy weather. Slightly damp, owing to lack of sun."

"The bad air from the drain, or water-closet, or both, is at times a most intolerable nuisance. Many attempts have been made to abate it, but without good results. It is said that all the neighborhood suffers in the same way."

"Behind the privy is a stable, which at times sends forth disagreeable odors."

"The boys' urinals should be located at a distance from the main building."

"Coal-gas or carbonic oxide. People do not know how to manage their stoves and furnaces. Janitors, as a class, are almost entirely ignorant of the effects of this poison. They all need instruction."

"Our comfort, health, and happiness have been greatly promoted by the services of an intelligent, neat, and faithful janitor. He is only fairly paid, and there is reason to fear that his pay may be cut down. This kind of economy is very expensive in health and comfort. I most earnestly protest against the practice, quite too prevalent, of employing any one who can sweep, or shovel coal, as the janitor of a schoolhouse."

"Privies so constructed that a large amount of excrement lodges on an inclined structure above the drain. The Board of Health [city] condemned our privies in strong terms two years ago; but nothing is done about it yet, and there seems to be no prospect. We have a covered way from the back door to the privies, but we keep it locked all the time, as, with the wind in certain directions, the odors are very offensive. The pupils go down to the basement, up into the yard, and enter the privies by a side door."

"The building ought to be raised five feet; the water-closets removed from the building, and properly ventilated. The house is not fit for any human being or animal to live in."

"No water-closet for teachers, except outside the building."

"I have never known the privies to be emptied." [The school has been built twenty-two years.]

"When the wind is east, the basement is sometimes full of foul odors."

"In one of my primary-school buildings, a sewer-drain ran through the cellar, and the odor pervaded the building. The children were sickly, and I noticed sores upon some of their faces. The teachers were ailing, and did not know what was the matter."

"Nausea, vomiting, severe headache, drowsiness, and general unfitness for school work. The odor is sometimes so offensive as to make it undesirable to open the windows for a change of air." [The privies are outside of the building.]

"The schoolrooms are low, badly ventilated, — chiefly by windows. The privies empty into a closed vault, — no outlet. They are sources of offensive odors. The neighbors have complained to the Board of Health of the city of Boston. Scarlet fever, diphtheria, diarrhœa, and kindred filth diseases, have been very fatal among the pupils; due in a large degree, I think, to improper ventilation and offensive odors."

"I think very stringent rules should be made in relation to the cleanli-

ness of pupils attending our public schools. It might be well to appoint an officer whose duty it should be to inquire into the condition of families in this regard, especially in certain localities."

"Soiled clothes, especially when wet, are a source of offensive malaria in schoolrooms. The parents are too poor, in many instances, to supply their children with more than one suit. Here is a field for benevolent people to operate in."

"Larger clothing-rooms, that the clothes of each child may be isolated. The clothing now in some schools is two or more garments deep, and has been the means of communicating disease, or, at any rate, vermin."

"Crowded, poorly-ventilated rooms are perfectly adapted to the spreading of any contagious disease."

General Conclusions.

A. The report is based on returns from nearly all the school-buildings in Boston, the total actually in use being 159, with an attendance of 46,418; also from schools not in Boston, estimated to number 400, with 40,000 children, or about one-sixth of the corresponding school population.

B. The sites chosen appear to be high, and well lighted in most cases; very often unprotected from the weather. The drainage of country school sites is reported as bad in one-seventh of the cases; in Boston, in a few. Among the points complained of by correspondents, the following are the most striking: —

Dampness of walls or floors. Stagnant water in neighborhood. House originally set too low for drainage. Entire absence of sunlight in a room. Nuisances from loungers.

C. The ventilation is very generally said to be poor; the heating, in most cases, to be adequate; the floors and walls of rooms to be dry. Complaints are made of misdirection of funds, by which exterior ornament is added, to the neglect of essential portions of the ventilator-apparatus. Certain forms of stove objectionable. Bad location of ventilators in the room. Coldness of floor, with undue heat of upper air. Inattention to the state of the atmosphere, on the part of teachers; and sudden opening of windows in cold weather. Neglect by janitors.

D. A cellar or basement is absent in a number of country schools. When present, it is usually employed for storing fuel, and for furnaces; often also for play-rooms; not infrequently for water-closets or even privies, and in a very

few cases for schoolrooms. A communication with the privy (out of doors) exists sometimes; and the necessity of strict attention to the state of the air in cellars, and constant ventilation *in all cases*, is appreciated by a number of correspondents.

E. Water-closets are frequent; earth-closets only twice mentioned, both times with approval. As to privies, those of many country schools have no vaults at all; and where vaults exist, they are scarcely ever emptied as often as they should be (viz., once a month at the least). Exposure of the children to the weather in visiting privies is very general, and by some is considered a source of disease. Separate provision for the sexes is usual. Offensive odors are usually complained of; a few very aggravated cases are given. Ventilation of the privies is not often in a proper state. The following are the chief additional complaints: —

Privies in cellar, or opening directly into schoolrooms or basement. Vaults draining into soil; emptied rarely or never; leaky; flushed only by occasional rain-fall; without outlet; built so as to be inconvenient for emptying. Absence of vaults. Gross filthiness of scholars.

In the city of Boston, a large number of vaults discharge at a point eighteen inches above the bottom; thus in many cases a layer of fæcal matter is formed, which probably is never wholly removed by flushing. Some are only flushed by rain from the roof, — a very uncertain supply. Others are furnished with jets of Cochituate water. Of late years, a good many have been made upon correct principles, viz., with bottoms cemented, and inclined to an outlet; the latter is closed with a plug, which is daily removed, and the whole cavity flushed.

Few correspondents have ascribed injury to health directly to the state of privies. The effects mentioned by those who speak of them are, catarrhs, dyspepsia, debility, diarrhœa, dysentery, and zymotic disease.

F. Many of the replies indicate an absence of experience in regard to contagious diseases in schools. Of the country correspondents, however, one-third express an opinion that schools are a frequent cause of the propagation of such diseases; often so, in their own experience. The usual preventive means (isolation and disinfection) are mentioned in

various forms by a considerable number. In Boston and some other cities, the preventive measures adopted by the authorities are considered to have reduced the danger from this source to a small amount. In lieu of a summary of the opinions of correspondents, the reporter would here offer a statement of the points which should be attended to in framing

Rules for Preventing the Spread of Contagion in Schools.

1. Vaccination, — a certificate to be required of every child entering the public schools, as is the law now in Massachusetts.

2. Physicians to be required, under penalties, to report to local Boards of Health all cases of dangerous infectious diseases observed by them, the Board to inform principals of schools.

3. The existence of any case of such diseases in a house, to exclude the inmates from attendance at schools, for a sufficient length of time; the propriety of re-admission being certified to by a competent physician.

4. Disinfection[1] of premises and clothing, by the Board of Health, in every house where the above diseases have prevailed.

5. Medical authority to be designated, for the purpose of advising teachers and pupils, and pointing out to the school committee matters in regard to which their authority might be used to improve the sanitary condition of schools.

Finally, it should be clearly understood that schools are often blamed for evils not fairly attributable to them; and it is not meant that by any means all the influences injurious to health, during the school age, are due to the schools. Enough, however, comes from that source to make great improvement in that direction possible. Hereditary taint, bad home-education, insufficient sleep, late hours, improper or insufficient exercise, unsuitable food, clothes ill adapted to their true function, all come in for their share of blame; but even in these points, school-instruction, if under wise general directions, can do a great deal to counterbalance evil influences coming from other sources.

[1] As to disinfection, the reader is referred to the account of the methods now most approved, contained in the present Report, in a paper on Scarlet-Fever.

SCARLET-FEVER.

BY

A. H. JOHNSON, M.D.,

MEDICAL CORRESPONDENT OF THE BOARD IN SALEM.

SCARLET-FEVER.

Two features of this disease have beguiled communities into irresoluteness concerning active measures to prevent its extension. One is the great irregularity in the frequency of its epidemic appearance; the other, the wide fluctuations in the measure of its severity. One of the most striking illustrations of the first-mentioned feature is given by Dr. Caspar Morris,[1] who quotes Dr. Emerson of Philadelphia, as saying, "It is a remarkable fact, that in the twenty-one years from 1807 to 1827 inclusive, the total mortality from scarlet-fever was only 102 out of 53,000 deaths. Doubtless some cases were reported in the bills of mortality under the vague title of "sore throat," of which the amount during the whole period referred to was 355; but, with such additions, the proportional mortality from scarlet-fever would be trifling, compared with its ravages in more recent years. *Only one death was reported in* 1827, *not one in* 1828; in 1829 there were nine; in 1830 there were forty. Since the last-named year, the mortality from this source has very much increased, as will be apparent from the number of deaths reported in the subsequent ten years: viz., in 1831, 200; 1832, 307; 1833, 61; 1834, 83; 1835, 205; 1836, 240; 1837, 205; 1838, 134; 1839, 225; 1840, 244."

When any disease for a period of twenty-one years may prove to be so little prevalent as to cause hardly two in one thousand of the deaths from all causes, we can hardly wonder that the generation favored with such immunity should grow quite content with the measure of protection it has enjoyed, and become sceptical concerning the power of this disease to produce any considerable or terrible ravages.

Varying Fatality of Scarlet-Fever.

The second of the above-named features of scarlatina, even more than the first, because more frequently witnessed, has

[1] Essay on Scarlet-Fever, by Caspar Morris, M.D. Philadelphia, 1858.

led to very varying and vacillating opinions concerning the dangers to be apprehended from the action of the scarlatina poison. Many cases of this disease are attended with so little constitutional disturbance, as to justify Sydenham's statement, that "it was the mere name of a disease, much less to be feared than measles." On the other hand, many other cases exhibit such a complication of distressing symptoms, and so surely run a fatal course, notwithstanding all remedial measures, as to make its very name a terror to households. What is true of different individual cases, appears also to be true of different epidemics. During some years, nearly all cases of scarlatina will be attended with a moderate amount of discomfort, and terminate with rapid convalescence; in other epidemics, the large majority of cases manifest great malignancy, and terminate in death.

Graves,[1] in his Clinical Lectures, states, that "in the years 1800 to 1804, scarlet-fever committed great ravages in Dublin: the type which it assumed was most virulent, sometimes terminating in death as early as the second day. It thinned many families in the upper and middle classes, and left not a few parents childless. From the year 1804 to 1831, scarlatina epidemics recurred, but always in a mild form, so much so that many were led to believe that the fatality of the former epidemics was chiefly, if not altogether, owing to the erroneous method of cure adopted by the physicians of Dublin." He goes on to say, "The experience derived from the present epidemic has completely refuted this reasoning, and has proved, that, in spite of our boasted improvements, we have not been more successful in 1834–5 than were our predecessors in 1801–2." Dr. Louis Thomas [2] states, that in England and Ireland, "after an unusually mild appearance during the beginning of the nineteenth century, scarlatina, since the fourth decennium, suddenly began to assume not only much more dangerous forms, but also attained a very unusual spread."

This great variation, in the violence of different epidemics, may be one of the reasons why efforts to secure legal enactments to aid in checking the ravages of this disease have not been more earnestly and persistently made. A community

[1] See Hillier's Diseases of Children, p. 296.
[2] Ziemssen's Encyclopædia, vol. ii. p. 160.

at one time alarmed by the rapid extension of severe and fatal forms of scarlatina, may become clamorous for protective measures; but, before such measures can be fully devised and put in force, experiences with this disease, in which children are scarcely confined to their beds, reassure the anxious, and produce a delusive faith that it is so easily controlled, that, like mumps and chicken-pox, it may be classed with the more trivial and common sicknesses of childhood, against whose contagion there is no urgent need to provide.

It is evident, that a limited personal experience or knowledge of the infection of scarlatina may lead to a most dangerously erroneous judgment concerning its possible malignant workings. Yet this is the kind of knowledge on which any given community is prone to base its public action. Moreover, the people generally are most impressed by recent experiences, and have a tendency, at times fortunate, yet again disastrous, to forget or ignore past occurrences. It seems, therefore, to be the duty of those whose political, professional, or social standing naturally constitutes them conservators of the public health, not only to form their own opinions upon information widely sought, but to inform those who have neither time nor means to make sufficient personal investigation, concerning the nature and magnitude of the evils with which they have to contend.

Mortality from Scarlet-Fever.

Among the active causes of mortality, but few of the prominent forms of disease more urgently claim our attention than scarlatina. The different names given to this disorder have created in many minds false ideas of its nature. In popular usage, the terms scarlatina and scarlet-rash are supposed to indicate diminutive forms of scarlet-fever, while the term malignant scarlet-fever is thought to indicate a peculiar virulence in the infection. It is exceedingly important to remember and to teach, that these terms do not designate differences in the specific contagion to which different phases of this disease are due; that these terms all refer to the working of the same poison; and that the varying degrees of severity of the disease depend not wholly on the apparent mildness or malignancy of the fever in persons

from whom contagion may come, but upon the bodily condition and surroundings of the person attacked. When people more universally understand that the contagion from the mildest form of scarlet-fever may produce the so-called malignant form of the disease in another member of the same family, they will be more willing to adopt stringent precautionary measures, to restrict the spread of contagion from trivial forms of this disease.

"According to the statistical tables of Farr,[1] the annual mortality from scarlatina in England and Wales from 1848 to 1855 comprised one twenty-fifth, and in some years even one-twentieth, of the entire death-rate." "Scarlet-fever[2] has, since the beginning of 1848, a period including three epidemics of cholera, numbered more victims in London than cholera. From the latter disease, the deaths in three epidemics were 30,452; whilst from scarlatina, between January, 1848, and December, 1866, the deaths in London numbered no less than 52,461. Mr. John Simon, in his Twelfth Report as Medical Officer of the Privy Council of England, states that "In the two years 1863–64 scarlatina destroyed in England more than 60,000 persons; and, so far as comparison can yet be formed between that and the present epidemic (1869), it seems probable, that the present epidemic is of at least equal severity."[3] Dr. Farr states that[4] "In the last two decenniads, 1851–70, in all England the mortality per 100,000 by small-pox declined from twenty-two to sixteen, or to the extent of six; but, population growing denser, the mortality by scarlet-fever rose from eighty-eight to ninety-seven, thus increasing nine, or one and a half times as much as the mortality by small-pox decreased."

According to a "Table of Mortality," derived from the "English Life-Table," showing of what diseases and at what ages 1,000,000 live-born children may be expected to die, it appears that "under five years 263,182 may be expected to die. Of these 3,331 will die of small-pox, 11,507 of measles, 17,959 of scarlet-fever, 2,425 of diphtheria, 14,424

[1] Thomas on Scarlatina: Ziemssen's Encyclopædia, vol. ii. p. 160.

[2] Diseases of Children, p. 295, Hillier.

[3] Twelfth Report of the Medical Officer of the Privy Council, England, 1869; p. 12.

[4] Supplement to the Thirty-fifth Annual Report of the Registrar-General, 1875; p. 7

of whooping-cough, 20,344 of diarrhœa and dysentery. At five and under ten years of age, 34,309 may be expected to die ; and of these 833 will die of small-pox, 1,080 of measles, 8,743 of scarlet-fever, 1,364 of diphtheria, 682 of whooping-cough, 427 of diarrhœa and dysentery." During the ten years from 1861–1870, with a mean population in England and Wales of 21,389,245, the total number of deaths from scarlet-fever was 207,867 ; while the total number of deaths from small-pox was 34,786, from measles 94,099, from diphtheria 39,454, from whooping-cough 112,800, from diarrhœa and dysentery 207,256, from all causes 4,794,500. From this it appears that the mortality from scarlet-fever, at all ages, exceeded that of any other one of the acute "zymotic" diseases.

These statistics, from the admirably calculated and tabulated reports of Dr. Farr, exhibit with shocking distinctness the formidable nature of this disease, and its terrible power to blight at once the hopes and happiness of many households, by its fatal work on the most promising children. Nor is this a remote evil, scourging with peculiar violence the population of a distant country. If it were so, the contagious nature of the disease, and the extensive and constant intercourse with Great Britain, would give cause enough for anxiety, and for vigorous efforts to prevent the importation, and to restrict the extension of so fatal a malady. The mortuary statistics of our own country are no more assuring. Imperfect as these statistics may be, owing to various causes, their error is rather in the direction of under-stating, than of over-stating, the number of deaths from any special cause.

The following statements, taken from the tables given in the United States Census Report for 1870, will give some idea of the prevalence of scarlet-fever in the United States.

	1850.	1860.	1870.
Total number of deaths from all causes,	323,023	394,153	492,263
Number of deaths from scarlet-fever, .	9,564	26,402	20,320
Number of deaths from scarlet-fever out of 100,000 deaths from all causes, . .	2,967	6,698	4,128
Number of deaths from all causes to one from scarlet-fever, ...	34	15	24
Number of deaths from measles, . .	2,983	3,899	9,237
Number of deaths from all causes to one from measles, ...	108	101	53
Number of deaths from small-pox, . .	2,352	1,271	4,507
Number of deaths from all causes to one from small-pox, ...	137	310	109
Number of deaths from whooping-cough,	5,280	8,408	9,008
Number of deaths from all causes to one from whooping-cough, ...	61	47	55

From this it appears, that while as we have already quoted, the annual mortality from scarlet-fever, "in England and Wales, from 1848 to 1855, comprised one twenty-fifth, and in some years even one-twentieth, of the entire death-rate," the average annual mortality from the same disease in the United States for the census years 1850, 1860, 1870, was one twenty-fourth, and in 1860 one-fifteenth, of the entire death-rate. This proportion, it will also be seen, greatly exceeds that borne by the mortality from the other actively contagious diseases, measles, small-pox, and whooping-cough.

The evils which may be wrought by scarlet-fever are brought much nearer for our consideration by the following statistical table, as edited by Dr. Draper in his Analysis of the Registration Reports to the Legislature of Massachusetts, from which we learn how tenaciously the infection of this malady holds a place among the homes in our State, and at times brings on an outbreak of sickness attended with extensive fatality.

Annual Mortality from Scarlet-Fever in Massachusetts for the Period of Twenty Years, 1856–1875.

YEARS.	Deaths from Scarlet-fever.	Percentage of deaths from Scarlet-fever to deaths from all causes.	Death-rate per 100,000 living.
1856, ...	1,252	6.04	109
1857, ...	2,013	9.36	172
1858, ...	1,051	4.99	88
1859, ...	1,038	4.88	86
1860, ...	916	3.92	74
1861, ...	1,137	4.66	92
1862, ...	1,261	5.42	101
1863, ...	1,399	5.01	111
1864, ...	1,503	5.21	119
1865, ...	807	3.06	64
1866, ...	385	1.58	29
1867, ...	828	3.63	62
1868, ...	1,369	5.35	91
1869, ...	1,405	5.39	99
1870, ...	683	2.49	47
1871, ...	867	3.10	58
1872, ...	1,377	3.93	89
1873, ...	1,472	4.34	94
1874, ...	1,382	4.33	86
1875, ...	1,684	4.81	102

This table illustrates the great variation in the prevalence, or in the fatality, of this disease in different years. In the year 1857, we find the percentage of deaths from scarlet-fever to deaths from all causes to be 9.36; which per cent was reduced in 1865 to 3.06, and in 1866 to 1.58, to rise again in 1869 to 5.39. It fell again in 1870 to 2.49, since which time it steadily increased to 1875. This is well shown again in a portion of another of the tables, in the report already referred to, which exhibits the order of succession of ten principal diseases.

Order of Succession of Ten Principal Diseases for the Years 1870–1875.

1870.	1871.	1872.	1873.	1874.	1875.
Consumption.	Consumption.	Consumption.	Consumption.	Consumption.	Consumption.
Cholera infantum.	Pneumonia.	Cholera infantum.	Cholera infantum.	Pneumonia.	Pneumonia.
Pneumonia.	Cholera infantum.	Pneumonia.	Pneumonia.	Cholera infantum.	Cholera infantum.
Old age.	Old age.	Typhus.	Old age.	Old age.	Old age.
Typhus.	Heart disease.	Old age.	*Scarlatina.*	*Scarlatina.*	*Scarlatina.*
Paralysis and apoplexy.	Typhus.	*Scarlatina.*	Typhus.	Heart-disease.	Heart-disease.
Heart-disease.	Paralysis and apoplexy.	Heart-disease.	Paralysis and apoplexy.	Typhoid-fever.	Diphtheria.
Infantile.	*Scarlatina.*	Paralysis and apoplexy.	Heart disease.	Paralysis.	Typhoid-fever.
Scarlatina.	Infantile.	Cephalitis.	Infantile.	Cephalitis.	Paralysis.
Cephalitis.	Cephalitis.	Small-pox.	Cerebro-spinal meningitis.	Cancer.	Cephalitis

We have here exhibited, not only the steady increase of an epidemic of scarlet-fever, but also the high rank which this disease takes among the chief causes of mortality in our own State. Moreover, it is at times more or less active in all parts of the State. In 1875, when the epidemic was at its height, Dr. Draper states that "none of the counties escaped invasion." Replies received from correspondents of the Board of Health show, that here and there small communities enjoyed comparative immunity from this dreaded sickness, while in the larger towns and cities, in the eastern part of the State, it was exceedingly prevalent. In our larger cities the scarlet-fever poison seems to find abundant lurking-places, and so persistently reveals its presence, and contributes to the annual amount of mortality, that communities accept it as one of the natural and necessary afflictions and foes to childhood. Of scarlet-fever in Boston, during the years 1849 to 1874, Dr. Curtis writes, "During the entire period of twenty-six years (1860 omitted), scarlet-fever has caused a total of 5,194 deaths, *which is more than double the mortality due to small-pox during the same period.*" Comparing the course of scarlet-fever with that of small-pox, Dr. Curtis says, "The disease (scarlet-fever) is much more uniform in its degree of prevalence; indeed, it is so unremittingly present, year after year, as to deserve the name of an *endemic* disease. Only in the years 1850 and 1851, 1854 and 1855, 1865 and 1866, has the number of yearly deaths fallen below a hundred; and even in these years, the deaths by scarlet-fever were still so numerous, that the comparative remissions are hardly sufficiently marked to constitute intervals between successive epidemics."

Relation between Deaths and Cases of Scarlet-Fever.

We are to bear in mind, that mortuary statistics only very partially declare the degree to which such a disease as the one we are considering, has prevailed. They give us no record of the many-fold larger number of those who were ill, yet more or less completely recovered. Nor can we, with any satisfactory accuracy, determine the measure of the evil this disease may have inflicted, by estimates of an ordinary percentage of deaths to recoveries. In no disease is the rate of mortality more variable. It depends largely upon the phys-

ical condition and surroundings (in the largest sense of this word) of a community exposed to the infection; or, in other words, upon the character of the epidemic. Dr. Hillier[1] tells us, that "In the course of twelve years, the annual mortality from scarlet-fever, in the London Fever Hospital, varied from one death in forty cases to one in six; or, in other words, from 2.5 to 16.5 per cent. In the Hospital for Sick Children, the annual mortality has varied in different years, from nine to thirty-one per cent." Dr. G. Gregory[2] states that "six per cent may be assumed as the medium rate of mortality." Dr. Thomas writes:[3] "Epidemics of scarlet-fever, where the mortality is below ten per cent, may be regarded as benign epidemics, comparatively speaking. The majority of epidemics described lately, have shown a much greater mortality; and yet it must not be assumed that the statistics, which have been made known to us in most of the publications, illustrate the average mortality of scarlet-fever, for an epidemic has often been reported because it was remarkable for its virulence. The mortality very frequently reaches between thirteen and eighteen per cent; but in not a few epidemics it is as high as twenty-five per cent, or may even reach between thirty and forty per cent." Dr. Farr publishes the following table, with comments in reference to the *minimum* mortality.[4]

The Life-Table Deaths to 1,000,000 *Children born alive are:* —

	In Healthy Districts.	In England.	In Liverpool.
By Small-pox, . . .	2,359	6,521	8,141
Measles, ...	6,912	12,865	26,973
Scarlatina, . . .	21,403	30,021	38,302
Whooping-cough, . .	10,234	15,161	34,021
Typhus (including enteric and common fever) .	28,146	38,107	76,563

"If every child is attacked by scarlet-fever at some time of life, then there are one million cases, and, by the English Life Table, 30,021 deaths: so the mortality of the cases is

[1] Hillier on Diseases of Children, p. 297.
[2] Morris on Scarlet-Fever, p. 64.
[3] Ziemssen's Encyclopædia, vol. ii. p. 291.
[4] Supplement to the Thirty-Fifth Annual Report of the Registrar-General, London, 1875.

three per cent. The mortality of cases is at the rate of two per cent in the healthy districts, four per cent in Liverpool. This is the minimum mortality of cases, for thousands die young of other diseases before they can be attacked by scarlet-fever."

Relative Fatality in Massachusetts.

In order to learn not only the degree of severity and fatality, but also the extent to which scarlet-fever has prevailed in our own State, and the class of our population it has most afflicted, the following inquiry, among others, was made of the correspondents of the Board: "Estimating from your own practice, and so far as possible from the practice of your associates, what per cent of all cases of scarlet-fever prove fatal? and how is this percentage affected by age?"

One hundred and ten replies were received. Of these, forty state that cases of scarlet-fever have been so few, or epidemics so light, or their contact with the disease so infrequent, that no data have been obtained wherewith to answer this question. The average rate of mortality stated by the remaining seventy, is between nine and ten per cent. The extremes of variation, from a trivial ailment to a most malignant pestilence, appear in these replies, and need to be considered in our estimate of its ordinary rate of mortality. One correspondent states, that in upwards of one hundred cases, not one proved fatal. Other correspondents state the rate of mortality as low as one-eighth of one per cent, less than one per cent, between one and two per cent, two per cent; while others still have met with epidemics whose fatality was twenty-five per cent, thirty per cent, and even fifty per cent.

If we select those replies in which the number of fatal cases did not exceed ten per cent, we have fifty-one accounts of observations, in which the average rate of mortality was less than six per cent.

These replies, at the same time that they indicate the difficulty of exactly fixing the degree of fatality attending scarlet-fever, owing to the protean phases it assumes, strikingly conform to the opinions we have quoted from English and other authorities. It is evident that we shall not be far from the truth in accepting six per cent as the average rate of mortality from this disease during a long period of years.

If we reckon with this percentage, we find, that as there were 1,684 deaths from scarlet-fever in Massachusetts during the year 1875, there were probably 28,066 sick with this disease; and, since during the thirteen years from 1863 to 1875 there were 15,161 deaths from scarlet-fever, there were probably during the same time 256,016 persons suffering from this fever. During the twenty years from 1856 to 1875, there were 23,829 deaths in our State from scarlet-fever; probably during the same period, 397,150 persons sickened with this disease.

Such statistics of the amount of suffering inflicted by any one malady, but faintly reveal to us the extent of the pain and grief it has occasioned. They give us no record of the sickening fears, exhausting watchings, sacrifices of comforts, business opportunities, and personal health, which the relatives and friends of the sick undergo; nor do they picture for us the blighted happiness and hopes of many households, nor make known the irremediable loss, which fixes a burden to last as long as life, in the hearts of parents, and wide circles of kindred and associates.

Incomplete Recoveries.

The figures we have given would doubtless appear much larger, if all the deaths whose primary cause was scarlet-fever were directly attributed to this disease. Various morbid processes, set in action by the poison of scarlet-fever, and which persist after the primary symptoms of this disease have disappeared, may, after a long interval, terminate in death. The causes of these deaths are then likely to be recorded, according to the particular organs or functions which were most prominently affected. Many of the cases recorded as dropsy, inflammation of the kidney, convulsions, pleurisy, albuminuria, abscess of the ear, inflammation of the brain, brain-disease, scrofula, diphtheria, tabes mesenterica, joint-disease, noma, and others, may have had their origin in scarlet-fever.

Dr. Stallard[1] thinks this is peculiarly the case with deaths among members of the poorer classes in London. He says, "In scarlatina the deaths among the poor are indirect; they follow the primary disease after a considerable interval, have

[1] London Medical Times and Gazette, March, 1859.

no very obvious connection with it, and they appear under other names in the report of the registrar-general." There is, no doubt, a similar lack of exactness in the returns of the cause of death for our own State records. Hence our registration reports fail to reveal to us the whole of the fatality from scarlet-fever. But we are reminded by these deaths "indirectly due" to this fever, of that very considerable number of persons who date the commencement of their chronic invalidism, or their loss of hearing, or impairment of vision, or lameness, or their sufferings from glandular enlargements, and their small powers of endurance of, or resistance to, the ordinary trials of physical vigor, — to the destructive or devitalizing action of the scarlet-fever poison. We know that in some epidemics this fever has been scarcely more to be dreaded for its fatality than for the maimings, disabilities, and lamentable physical transformations, it produces in many of its victims. The exact proportion which these incomplete recoveries bear to the whole number of cases of scarlet-fever, it is, of course, very difficult to determine. The great variations in the severity of the disease in different epidemics, appear to occasion a corresponding variation, in the permanence of the injuries it inflicts, upon those who survive its primary effects.

Not expecting any exact measurement of the evil incurred by reason of *partial* recoveries, but in order to make the presence of this evil more apparent, the following question was put to the correspondents of the Board: "What per cent of recoveries from scarlet-fever are permanently incomplete?"

Out of the 110 replies, fifty-four answer, that they cannot state the per cent; some because their experience has been chiefly with the lighter form of the disease, and some because they have no sufficient record to guide their estimate. The average stated by fifty-four others is six per cent. Of these, twelve think the per cent is one or a fraction of one. One of the fifty-four finds forty, another thirty, and two twenty-five per cent, the portion of incomplete recoveries.

The extremes we have stated of the estimates made by correspondents, we may explain partly by differences in the character of the population, and of their habits of living, partly by the varying violence of epidemics, partly by limited and exceptional experiences, and partly by differences in the

amount of gravity imputed to changes in tissues, or modifications of function, which this disease has produced. It is in this way we are to explain the replies of two correspondents, whose estimates are so exceptionally large, that we have thought it right to exclude them, from affecting the general average. One thinks the proportion of incomplete recoveries as high as sixty per cent, another as high as sixty-five per cent.

As is well known, the effects of the scarlet-fever poison in perverting nutrition and tissue growth, and of retarding and modifying development, are so frequently seen in the young (and this fever is, as we shall see, largely a disease of childhood), that there is room for great variation in judgment as to what constitutes a complete recovery. Some will consider the absence of any local defect in structure or function, as evidence of perfect restoration; while others, in cases where every organ of the body seems sound, and all the functions well performed, will detect a restriction of the development, a limitation of the physical and mental force and aptitudes, which were reasonably to be expected, from constitutional characteristics exhibited previous to the occurrence of the fever.

Scarlet-Fever a Disease of the Young.

That the fatality (although perhaps not the greatest suffering) from scarlet-fever falls upon the young, is not only a popular impression, but is abundantly demonstrated. Dr. Murchison,[1] of London, publishes a table constructed from the death-returns for England and Wales, for the years 1847 and 1855 to 1861, and for London for 1845–46 and 1848 to 1854, "which gives a total of 148,829 cases; in which 63.87 per cent were of children under five years of age, 89.8 per cent were under ten years of age, 95.63 per cent were under fifteen years of age, and only 1.75 per cent exceeded twenty-five years." "Of the deaths from scarlet-fever in Philadelphia for a period of forty-five years, from 1831 to 1875 inclusive, 95.01 per cent were at ages under ten years, 73.37 per cent under five years, 3.44 per cent in the period between ten and twenty years, and 1.55 per cent at ages over twenty. It appears from these facts, therefore,

[1] The London Lancet, September, 1864, p. 483.

that scarlet-fever is pre-eminently a disease of infancy and childhood, and is particularly fatal in the first five years of life." [1]

The same fact is well illustrated in Dr. Draper's [2] Analysis of the Registration Reports of our own State, according to which the number of deaths from scarlet-fever during the year 1875 were 1,684; of these sixty-seven per cent were under five years of age, 91.44 per cent were under ten years of age, 4.51 per cent were between ten and fifteen years old, and only 1.85 were over twenty years old.

Liability of the Two Sexes.

This fever assails the sexes with great impartiality. In the statistics given by Dr. Murchison, and already referred to, it appears that of 148,829 deaths from scarlet-fever in England and Wales in 1847, and from 1855 to 1861, 75,373 were males, and 73,456 were females. According to tables published by Dr. Farr in the Supplement to the Report of the Registrar-General for 1875, of 207,867 deaths from scarlet-fever, during the ten years 1861–70, 105,368 were males, and 102,499 were females. From a table constructed from the Reports of the Registrar-General, from their commencement in 1837 down to 1861, Dr. Murchison states, "that scarlet-fever proved fatal to 157,416 males, and to 154,196 females." "This difference," Dr. Murchison states, "is explained by the circumstance, that the disease is somewhat more mortal in the male sex." And after a comparison of the deaths from scarlet-fever to the deaths from all other causes, he remarks: "It would appear then, that, without any reference to age, scarlet-fever prevails alike in both sexes." "Of [3] the sixteen thousand seven hundred and sixty-four (16,764) deaths from scarlet-fever in Philadelphia, during the past forty-five years, eight thousand two hundred and forty-three (8,243), or 49.171 per cent, were males, and eight thousand five hundred and twenty-one (8,521), or 50.829 per cent, were females, — an excess of the latter over the former of 1.658 per cent." During the year 1875, in Massachusetts, of 1,684 deaths from scarlet-fever, 863 were males, 820 were females.

[1] Report of the Board of Health of the City of Philadelphia, 1876.
[2] Massachusetts Registration Report, 1876, p. 99.
[3] Report of the Board of Health of the City of Philadelphia, 1876.

General Distribution of Scarlet-Fever.

A fact which greatly increases the gravity of this scourge, is its wide distribution over the countries it invades. Many other diseases, which slay their thousands annually, depend for their existence upon the concurrence of certain geographical, telluric, and climatic conditions, and are modified or restricted as these conditions vary or disappear. Various malarial poisons owe their peculiarities and special influence to the localities in which they are generated. The yellow fever of certain tropical countries, the paludal fevers of Southern low lands, and the malarial fevers of our Western States, fearful scourges as they are, present for our encouragement the fact that they cannot thrive outside of certain geographical limits. So the various affections of the respiratory organs, such as bronchitis, pneumonia, and phthisis, become more prevalent and largely fatal in those climates where coldness, dampness, and sudden extremes of temperature occur.

Diseases of the kidney, or liver, or bowels, may prevail or disappear, according to the character of a water-supply, or of the prevailing temperature, or moisture, or natural surroundings, of a given portion of country. But certain of the contagious diseases are not thus restricted. Their infectious germs thrive in all climates, and add their fatal work to that of all other disorders due to local causes. While consumption in some States, and malarial disorders in others, may each, in their respective localities, occasion more deaths than any one other disease, an infection like that of scarlet-fever, ubiquitous in all parts of our country, may cause an amount of mortality which will give it high rank among the chief destroyers of human life.

Source and Methods of Contagion.

This glance, at the extensive distribution and fatality of scarlet-fever, suggests how reasonable and humane a duty it is to consider, whether all has yet been done that should be, to arrest the ravages of this disease; and to consider whether some plan of action, agreed upon by physicians esteemed for their good judgment, and enforced by law, may not restrict within much narrower limits the spread of this infection.

Our judgment in this matter must be guided by what we can learn of the source and methods of propagation of this disease, and of the conditions which favor its extension. We must first learn the nature and methods of an evil, in order to combat it with the best promise of success.

Among those who have investigated the cause of scarlet-fever, there is a very general agreement, that the principal, if not the only, origin of the poison of scarlet-fever, is to be found in the bodies of those sick with the disease. Mr. John Simon[1] writes: "Of this subtle and destructive contagion, we know of no other birthplace than the human body." Dr. Thomas[2] says: "In the large majority of cases, the scarlatina poison can be proved to have emanated from sick persons; or we can, at least, trace its course with more or less certainty from these to the newly-affected persons. Nevertheless, there are cases which appear to have had no local or temporary connection whatsoever with others, which fact has given rise to the opinion, that scarlatina could originate spontaneously, through the agency of certain unknown atmospheric and telluric conditions. But if we remember how easily the poison may be transported to great distances, and how long it will, in a latent condition, adhere to substances, it will be difficult to produce evidence of its ever having originated spontaneously in an isolated instance; not to mention the question, why this individual alone should have been influenced by these hypothetical agencies." Hillier[3] says: "The only *known* cause of the disease is contagion: *we do not know* whether it ever arises *de novo* in the present day;" although he adds, "I am strongly inclined to the belief, that it does sometimes originate without exposure to infection."

The contagious matter of scarlet-fever has not yet been isolated from the tissues and fluids of the body in which it exists. Neither its microscopical nor chemical characteristics have been determined. The present condition of modern inquiry into the nature of infectious matter may be stated in the two following quotations. Dr. Sanderson,[4] after a very

[1] Twelfth Report of the Medical Officers of the Privy Council, p. 13.
[2] Ziemssen's Cyclopædia, vol. ii. p. 193.
[3] Hillier on Diseases of Children, p. 297. The Italics are ours.
[4] Twelfth Annual Report to the Privy Council, Appendix, p. 254.

critical examination into the physical properties of contagia, gives a summary of his analysis, in which are the following statements: . . . "One doctrine has been advanced, which seems to us so important that we have ventured to call it fundamental. . . . The fundamental inference referred to is this: that every kind of contagium consists of particles. . . . On grounds which have been stated, we regard it as probable that contagium particles are spheroidal, transparent, of gelatinous consistency, of density nearly equal to that of the animal liquids in which they float, and that they are mainly, but perhaps not exclusively, composed of albuminous matter."

Dr. Thomas E. Satterthwaite,[1] in a very thorough and able paper on "The Present Condition of the Evidence concerning Disease-Germs," read before the Section on Sanitary Science, of the International Medical Congress at Philadelphia, 1876, submits the following conclusions with regard to the present status of the question: —

"I. That, as far as inquiry has been made as to the nature of the active principles in infective disease, it is probable that in a certain number the matter is particulate or molecular in form.

"II. That in regard to the causes of septicæmia, pyæmia, puerperal fever, erysipelas, and hospital gangrene, and those of cholera, vaccine-disease, the carbuncular diseases of men and animals, typhoid and relapsing fevers, and diphtheria, there is not satisfactory proof that they are necessarily connected with minute vegetable organisms.

"III. That the real nature of these causes is still uncertain."

What is stated by Dr. Satterthwaite in his second conclusion, concerning the contagium of cholera and the vaccine disease, can with as much truth be said of the infection of scarlet-fever, since this continues to elude investigation. While we are in doubt as to the *precise* material form and chemical constituents and properties of this poison, we know that it has a material existence, whose characteristics we must learn from its manifestations, and the conditions which most constantly attend them.

[1] Transactions of the International Medical Congress, p. 1,028.

Contagiousness.

"Scarlet-fever is the very type of what has always been, and still is, regarded as a contagious and infectious malady."[1]

If we enumerate the conditions which the scarlet-fever poison seems to elect for its transmission, in the order of their favorableness to the communication of this disease to others, they will appear very nearly as follows: —

I. Intimate association with one sick from scarlet-fever, — a fact which is confirmed by a very general experience.

II. Exposure, even though brief, to the same atmosphere which has been breathed by one sick from this fever. The degree to which the scarlet-fever contagium may be sustained in and carried by the air is not positively known. Dr. Davison believes, and Dr. Murchison agrees with him, "that the poison of scarlet-fever is much less volatile than that of measles."[2] Some think that this poison can be transmitted directly, only through short spaces of air: others believe[3] "that no susceptible person can remain in the same room, and hardly in the same house, without contracting it. The infecting distance is consequently much greater than in typhus."

III. Direct exposure to evaporating excretions of scarlet-fever patients, not only as they arise directly from the body, but as they are allowed to remain upon clothes, or in vessels in any occupied apartment. Dr. Richardson believes that the poison is "thrown off by the lungs or skin, probably with epithelium."[4] Dr. Murchison[5] writes, "The experiments and observations mentioned leave little doubt, that the poison is contained in the secretions of the skin and throat. It is highly probable that the other secretions are also impregnated with it, and particularly the breath and the glairy fluid which in severe cases is discharged from the nostrils; but this is an opinion founded on no positive data." Dr. Thomas[6] says there is "little doubt that the poison is present somewhere in the skin of the patient. It is probably also present

[1] Dr. Murchison on Scarlet-Fever. London Lancet, October, 1864, p. 540.

[2] London Lancet, October, 1864, p. 542.

[3] Aitken's Science and Practice of Medicine, vol. i. p. 320.

[4] London Lancet, vol. i. 1861, p. 517.

[5] London Lancet, October, 1864, p. 541.

[6] Ziemssen's Cyclopædia, vol. ii. p. 162.

in the pulmonary exhalations. . . . Other secretions may also be the carriers of the contagion; as, for instance, the nasal and pharyngeal secretion, perhaps also the urine."

There is reason to believe that the discharges from the stomach and bowels may also contain and communicate the infectious matter. Dr. Samuel Fenwick made investigations which went to prove "that the mucous membrane of the œsophagus, stomach, and intestines is inflamed in scarlet-fever; that desquamation of the epithelium of these parts takes place; that the condition of the skin is similar to the condition of the mucous membrane in scarlatina." With these evidences of morbid action produced by the fever in the membranes of the stomach and intestines, it is natural to infer that their products would contain contagion. Dr. E. Copeman[1] relates some cases in which negligence in the care of the excreta and bedroom-slops of scarlet-fever patients appeared to increase the severity of the fever. Probably new cases of this disease are not more frequently traced to the evacuations from the bowels, because those who have been exposed to such discharges also come in contact with other more direct and efficient means of infection. It is easy to see that cloths or vessels, containing the sputa and evacuations from a person impregnated with this poison, may easily infect one predisposed to the disease.

IV. The use of clothing which has been worn by one sick from scarlet-fever. One of our correspondents narrates the following incident in his own practice: "A child had died from scarlet-fever. A relative of the family several miles away borrowed or bought a blanket and a coat, several weeks after the death of the child, to use for her own child; and in a few days this last child was taken sick with the disease, and died. It had been exposed to the contagion in no other way. The garments had been used about the first child while it was sick." Our correspondent from Malden writes that he has met with repeated instances, in which the evidence showed that articles of wearing-apparel, especially the woollen clothing of scarlet-fever patients, which had been given away in charity after the death of the wearers, have, in numerous instances, carried the disease to the

[1] From St. George's Hospital Reports, 1870, vol. v. p. 71; in Braithwaite's Retrospect, vol. lxiv. pp. 21–23.

children of poorer families, and this, too, notwithstanding the articles in question had been carefully laid aside for many months. Another correspondent writes as follows: "N——'s child died of scarlet-fever. Weeks after, he sold the clothing to M——, whose children came down with the disease in just one week from the time the clothing was brought into the house." Another writes, that he knows of "one case where the dress of a child that had been sick with scarlet-fever lay in a bureau-drawer for eight months: this dress was sent to a relative twelve miles distant; and, as the result, a fatal case of scarlet-fever occurred in the family which received the clothing." Another states, that he has known "the clothes of deceased children to give the disease to previously healthy children, killing three of different ages, from two years to eighteen, in one family." Another "knew one case where the disease could be traced to no known or probable cause except a handkerchief, which had been used by a sick child, and then brought over a distance of five miles to the child that took the disease and died." As we farther on speak of the retention and transmission of contagion by articles which have had much less intimate and prolonged contact with the person, it will appear with unquestionable distinctness, that the clothing of those sick with scarlet-fever is likely to be abundantly charged with infectious matter.

V. Occupation of a bed, or use of lounges, or carpets, or upholstered furniture, which have not been disinfected, after use by a scarlet-fever patient. The long nap on blankets and carpets, and the woollen materials with which furniture is upholstered, together with the crevices and folds in such coverings, furnish perhaps the next most ready receptacles and tenacious retainers of contagious matter, whose particles can settle deeply into the spaces between the fibres, and be secure from dislodgment by any superficial brushing. One of our correspondents remembers, "a case where a carpet removed from a house where the family had had scarlet-fever, to another part of the town, communicated the disease to other children." Another correspondent knows positively, that in one instance a shawl conveyed the contagion, and that in another instance a sofa did it: he could exclude all other possibilities. Another correspondent thinks the

disease was contracted, "by sleeping on a feather-bed, two months after it had been used by a previous patient. The bed had not been fumigated, but had been kept in the open air several days. Other things were fumigated." In a case related by Dr. O. Marshall,[1] a person was taken sick with scarlet-fever seven days after sleeping on a lounge at a neighbor's house. Five weeks before, a patient with scarlet-fever had occupied this lounge.

VI. Occupation of a room which has been previously used by one sick with scarlet-fever, and not subsequently disinfected. "Benedict[2] cites a case where several children were seized with the disease immediately after their return to a room, in which a death from scarlet-fever had occurred, two months before, and which, in the interval, had been cleansed with all the care imaginable." Murchison[3] testifies that "in the course of practice I have repeatedly found scarlet-fever re-appear in a family, immediately after their return to their infected home, although several months had elapsed since the last outbreak, and the ordinary cleansing and disinfecting measures had been resorted to." Our correspondent from Haverhill recalls "a case, where the disease was apparently communicated, by means of 'germs,' retained in the wall-paper of the room, where the disease had occurred, to a new family, who moved into the house after it had been vacated, by the family in which the scarlet-fever first occurred." In corroboration of this explanation of the source of this disease, our correspondent from North Reading writes: "Scarlet-fever occurred in a house in this town in the winter of 1869. The house was vacated in the spring, and remained empty for the season. The next spring (1870) the house was repaired and painted inside, and the old wall-paper was thrown in a pile some distance from the house. A family moved in June, 1870, and soon after three small children of this family had the scarlet-fever. I found out that a few days previous to their sickness, they had been playing in this old paper. They all came out with the disease the same day. No other cases occurred in town that year."

VII. Intimate association with healthy persons who have recently visited scarlet-fever patients. There is an over-

[1] Report of Michigan State Board of Health for 1876.
[2] London Lancet, October, 1864, p. 542. [3] Murchison on Scarlet-Fever.

whelming amount of evidence to show that persons themselves unaffected by the disease may, either upon their persons or their dress, bear the poison of scarlet-fever long distances to others. Thomas "observed a case in which a nurse coming directly from a scarlet-fever patient communicated the disease, in the short space of three hours, to a child who had almost recovered from a tracheotomy." Willan, he says, "observed a similar case." We have questioned our correspondents, with the result of bringing in a large number of experiences illustrating the point. We quote some of them: —

One writes from Winchendon: "A short time ago a lady visited a family in a neighboring town, in which there was a case of scarlet-fever. In nine days after her return home, the children of her own family were seized with the disease. I could account for the disease in no other way." Another writes from Pittsfield: "A physician of this town called upon a family of children sick with scarlet-fever, leaving his own children in his carriage. On returning to his carriage he took one of his children in his lap, and drove away. Two weeks after, this child was attacked with the disease." A third writes from Dover: "A mother from South Boston buried a child in Dover; on the day of the funeral she visited another child living with its grandparents in Dover, wearing garments from the house, but not from the room, of the deceased child. In eleven days the second child came down with the disease. There were no other cases in town."

A fourth correspondent writes: "This very month this occurred: Mrs. W. watched with a child very sick from scarlet-fever. The next day she spent the afternoon with S. B., a quarter of a mile distant, who had not been out of doors for two weeks. In one week S. B. came down with marked scarlatina." Another writes from Winthrop: "A lady called upon a friend some miles from her home, held a child sick with scarlet-fever on her lap, in a short time returned home, took her own infant, and nursed it before changing her dress. The child was taken sick the tenth day after, and died in thirty hours of malignant scarlet-fever. There had been no other case in the town before, but the disease spread rapidly from this." A correspondent from Revere says: "I am quite sure the contagion is carried in the clothing, even by the physician visiting from patient to patient. Two years ago I lost a little daughter one month old, from scarlet-fever, which I brought from a visit to a patient sick with this disease." From Belchertown one writes: "A nurse from one of my cases of scarlet-fever carried the

infection to her family, one mile distant." Another writes from Becket: "I attended two children about two miles from my house, who were sick with malignant scarlet-fever. In six days after my first visit, my own three children were taken with the disease within a few hours of each other, and one of them died. The contagion was evidently conveyed in my clothing. The children were in no other way exposed to contagion."

Our correspondent from Ashland writes: "A and B, aged ten and seven respectively, brothers, sons of one of my Hopkinton patrons, on a visit to Boston. A taken severely sick with scarlet-fever, B directly taken home to Hopkinton to escape it. No scarlatina influence in Hopkinton. Twenty-five days after leaving his brother in Boston, B was taken very sick with scarlet-fever. The father was accustomed to go to Boston every three or four days to see son A, would stay in the sick-room several hours, and then come home and sleep (unknown to me) with son B. Here, either the period of incubation was twenty-five days, or else the father's clothes carried the contagion. I believe it was the latter." We give one more quotation relating to this point. It is from our correspondent in Hanover, who writes: "When the disease was prevailing eleven years ago, I was called in the night to visit a family four miles distant, where the disease was malignant; and on leaving buttoned my overcoat, and wore it so until I arrived home, and entered my lodging-room. A little daughter sleeping in the same room came down with the disease five days after, there being no other possible way of contracting the disease."

The manner in which the infectious material from scarlet-fever is transferred from one person to another, by an intermediate agent, is plainly susceptible of innumerable variations: consequently different observers are likely to explain the methods of conveyance very variously. One correspondent, speaking from his own tracings of causes, says: "I have come to the conclusion, that it was impossible to decide whether, in a given case, the contagion was transmitted by clothing, or by the individual; although I have thought that in a large majority of instances the individual affected with a very mild form of the disease was the real vehicle, even where the clothing had been credited with it." While this explanation may truthfully and most satisfactorily account for the instances this correspondent has witnessed, it probably would not satisfy those who had not only witnessed in others, but felt in themselves, robust health,

at the same time that they unwittingly were the carriers of infectious matter. In one instance, it may seem that the contagious material must have attached itself to the garments, in another to the hair, in another to the beard, or face, or lips, or hands. Two of our correspondents give instances in which, while the infected garments had been removed, and the bodies bathed, the uncleansed hair retained and transmitted the contagion.

VIII. Another of the conditions favorable to the communication of the scarlet-fever poison is the use of articles of nearly every description, which have been used by, or exposed in the room with, a scarlet-fever patient. Our correspondent from Spencer gives this illustration: "The mother of a child went to a neighbor, to assist where they had scarlet-fever, but took the precaution to leave her clothing, which she thought would in any way endanger her child, in an outbuilding; she afterwards gathered and washed them with the exception of her shawl. Some two weeks after, the child was seen to find the shawl, and in a few days came down with the disease, and died." From Chester we are told that "in one case, only a shawl was brought from an infected house: the contagion spread, and three persons died of scarlet-fever." From Newton we receive this account: "An adult visited her sister's family, four weeks after this sister's child had been taken sick with scarlet-fever. The house had been disinfected; but the child had still a blanket in its arms, 'as a comfort' the nurse said, which she had kept about her through the sickness. Every thing had been changed but this blanket. Ten days after exposure, the lady came down with scarlet-fever, mild in form."

Dr. Morris observed a case in which "a new dress was sent from a house in the city of Baltimore, in which scarlet-fever was prevailing, to a family in a secluded district of country in which the disease was not known. Several children, who were present at the opening of the box containing the dress, were seized simultaneously with the disease, which spread from them in the neighborhood." Dr. Percival of Dublin wrote to Dr. J. M. Good concerning the different types of scarlet-fever: "All have been produced by the same specific contagion, which in one instance was imported here from England in a Pandora's box containing plumed

soldiers, which had served to beguile the convalescent hours of a young family, and was sent by them as a present to their quondam playmates in this capital."

The writer of this article has recently observed an instance in which a child's playthings seem to have transmitted the contagion. He attended a young lad who was quite ill with scarlet-fever, and left him well advanced in convalescence on the 21st of October, 1876. On March 31, 1877, the only child of a neighbor walked out with its mother, for the first time for several months. Five months had passed since the occurrence of scarlet-fever in their neighbor's child; therefore they thought it quite safe to visit him for an hour in the room where he had been sick, for it had been cleansed and disinfected. While there the playthings which had been used by the sick child were brought out, among them a toy-horse covered with hair, which our little visitor handled freely. A little less than three days after this visit, he showed the premonitory symptoms of scarlet-fever, of which he died.

Dr. Murchison[1] has "met with several well-authenticated instances in which the poison of scarlet-fever appeared to be transmitted a long distance in a letter, or a lock of hair." Dr. Richardson narrates an instance in which "the poison was transmitted from an infected family to a house many miles distant, by means of a letter." A correspondent from Winchendon writes: "A niece of mine, who had been away from home for several months teaching, was taken with scarlet-fever (the disease prevailing in her school). While sick she wrote her sister seventy miles away. In nine days after receiving the letter, this sister was attacked with the same disease: she was on a farm, isolated, and there were no other cases in the town." Our correspondent from Malden says: "I might mention several instances in which friends of scarlet-fever patients believed the disease to have been transmitted by mail, through the medium of written or printed matter. . . . I subjoin," he writes, "the particulars of one such case, which I gathered recently from a credible source. Several years ago there lived in Charlestown in this State, a family of five children, two of whom were visiting a relative in Maine, when the three younger, who had remained at home,

[1] Murchison on Scarlet-Fever.

were one after another seized with scarlet-fever. After a prolonged struggle, two died. In the mean time, but not until four weeks had elapsed since they left their home in Charlestown, the disease attacked the absentees. For many months previous the town in which they were sojourning had been quite free from scarlet-fever; at least, such was the general testimony, as well as that of the attending physician. No suspicion of lurking infection attached to the premises. The house was new, occupied a retired situation, and had never before sheltered a scarlet-fever patient. The most searching investigation failed to disclose the source of the infection. The only questionable circumstance brought to light was the fact, that, previous to the outbreak of the disorder, the visitors had received several letters from home announcing the illnesses and deaths already mentioned."

IX. The fondling of domestic animals which have recently come from persons ill with scarlet-fever must favor the transmission of the poison. It is easy to see how the fur of the dog or cat may retain infectious matter for a time, as well as the nap of a blanket, especially in cold weather, when the moisture of a warm room is likely to condense on hairy and woollen coverings, which are brought in directly from a temperature below the freezing point. The condensed moisture may make the hair more retentive of infectious particles. Thomas[1] quotes from Züm and Heim and Krauss and Letheby, and the "Transactions of the St. Petersburg Medical Society," instances of a disease like scarlet-fever in the horse, dog, cat, swine, and cattle. "However," he says, "it is still an open question, whether the contagion of scarlet-fever really engenders these diseases in animals, and whether these in turn may infect man."

X. Visiting the body of one dead from scarlet-fever. On this point our correspondent from Winchendon writes as follows: "In the early part of my practice, four children in one family, being the first cases that had occurred in the town for several years, died. There was a school of about sixty scholars near by. The clergyman who attended the funeral of the first who died, being chairman of the school committee, stopped the school; and, out of forty who attended the funeral, thirty-seven took the disease." From

[1] Ziemssen's Cyclopædia, vol. ii. p. 166.

our correspondent at Webster we learn that "an only child, a girl eight years old, died from scarlet-fever. The burial was public; and at the end of three weeks, sixteen of the children who attended the funeral were down with the disease, and four of them died." Our Springfield correspondent states that "a man and wife from Connecticut came to this city to attend the funeral of a child dead from scarlet-fever. They remained but a few hours, and returned home. In a week their own child was taken with the disease. There had been no cases in the town previous to this, and none followed." From Rockport our correspondent writes: "The corpse of a person dead from scarlet-fever, brought here from abroad, was exposed in the church previous to interment. There was then no case in town. A few days after, one who attended the funeral, and was near the coffin, was struck down with the disease." Other correspondents speak of their knowledge of similar instances, without giving the particulars. It is an open question, whether, in the cases enumerated, the contagion was received directly from the cadaver, or whether from some one or more of the various accessories such as grow out of the preparations for interment, and conducting of a funeral. That the person and hair of the deceased should be charged with the infection, seems natural. But it is also probable that those who had been associated with the sick during the fever were present at some of these funerals, and more active distributors of poison than the corpse. However, since about a dead body there will generally be such accessories, which may retain the poison of an infectious disease which was the cause of death, these should be included in our understanding of what is involved in visiting a corpse.

Review of Testimony.

This review of some of the principal methods by which the contagium of scarlet-fever is distributed, although very incomplete, is sufficient to reveal how insidiously infectious particles may be disseminated, while the vehicle which transports them may escape detection. A few weeks ago, while instructing the parents of a child, sick with the disease, to keep from her use books or toys or other articles which could not be easily cleansed, my eye fell upon a book which

she had been using, which proved on examination to be a sabbath-school book. Should this book, several months in the future, chance to convey infection to any household, how mysterious the origin of the contagion might seem! Our failure, in many instances, to trace the source of isolated cases of fever, is the inevitable and natural result of the proven tenacity of this poison, and of the complications of the intercourse and intercommunications of society.

The experience of some physicians, who have found themselves utterly unable to unravel the circumstances by means of which the infection of scarlet-fever secured entrance to some households, has led them to question whether contagious matter was the *sole* source of scarlet-fever. Cases similar to the following, narrated by one of our correspondents, occur: "A family five miles from any known case of scarlet-fever was so blockaded with snow, that no team could pass the house for five or six weeks; when a child came down with scarlet-fever. Where did it come from? Was it generated *de novo*, or was it carried in clothing?"

Long Periods of Infecting Power.

The answer given to such cases turns largely upon the power of the infection of scarlet-fever to retain its energy for a long time. If this be proven, then it is quite possible that some portions of a house or its appurtenances, or some article carried into a house, may be charged with infection, and many months pass before the infection is so disturbed as to bring it into contact with susceptible persons.

Upon this point our correspondent from Watertown writes: "Liebermeister says, 'The spontaneous origin of small-pox, measles, and scarlet-fever, could scarcely find a defender now.' Coming from such a source, this is a very positive expression of the conviction that the existence of scarlet-fever proves the pre-existence or co-existence of *germs* of a certain kind. It has frequently happened that I have lost sight of scarlet-fever for several consecutive months, and have heard and known nothing of its existence in a pretty large geographical area for the whole period. Then the disease suddenly crops out in some unexpected place, and I start with a new series of cases, through the whole course of which I may trace the continuity of contagion

or infection. Now, if, in our etiological views of the disease, we accept the germ theory to the exclusion of all others, especially that which accepts the possible appearance of the disease by spontaneous origin, we are forced to conclude, either that the germs may preserve their vitality and power for months, or that they may be transported, with their efficiency unimpaired, from distant points, by indirect and circuitous methods."

It would seem that both these conclusions were abundantly justified by such evidence as is contained in many of the illustrations of the transmission of this disease which we have already given. Some of the cases we have quoted go to prove that the contagium of scarlet-fever may retain its evil energy from two to eight months. I subjoin some extracts from the replies of correspondents, which, at the same time that they illustrate the long periods through which the scarlet-fever poison may preserve its virulence, will also show how tenaciously it clings to, and how subtly it eludes removal from, a house it has once infected.

Our Becket correspondent says: "Some fifteen years ago, I saw several cases of scarlet-fever of a severe type, in a small house in Middlefield. One child died. The family removed from the house as soon as the health of the other children would permit; and the house remained closed from the month of April till the October following, when a family with several children moved into the house; and in a few days the children were taken with the disease in a severe form. No other cases were in the neighborhood." Our Winthrop correspondent states that "a family moved into a house; and, soon after entering the house, some of their number sickened with scarlet-fever, which was prevalent in the neighborhood. They moved out the following spring, having occupied the house just one year. Another family shortly after took the house; whereupon, after about two weeks, some of the family were taken sick with the same disease. No other cases occurred in the vicinity."

Our correspondent from Hyde Park writes that "a house where a severe attack of scarlet-fever had occurred in the spring was vacated as soon as the family were able to be moved. It remained vacant through the summer, was thoroughly cleansed and painted; but scarlet-fever again ap-

peared in the family that occupied it in the fall." "Our Webster correspondent says: "I remember a case that occurred several years ago. There were two children in a family. One of them was taken sick with scarlet-fever. The well child was at once sent thirty or forty miles away to some friends, and remained away three months, until the disease had entirely disappeared from the neighborhood of its home. The sick child died in a week or ten days after the second left home. The house was most thoroughly cleansed, painted, and papered, after the death of the first child. The second child returned, as above stated, after three months, and in two weeks was taken ill with scarlet-fever, and died. There were no other cases in the vicinity at the time." Several similar facts have been recorded by Dr. Marshall.[1]

The cloak of von Hildebrand, which figures in a great many treatises on scarlet-fever, because of the reliance placed on the carefulness and accuracy of its wearer's observations, had been shut up in a chest considerably more than a year after it had been worn in Vienna during the prevalence of scarlet-fever: yet Hildebrand believed, that, wearing it from that chest, he carried the disease to Padolia.

If we couple the possible long-continued dormancy of infectious particles, to the tenacity with which they cling to various articles as they are borne over long distances from place to place; if we then add the fact, that, in order to produce a specific sickness like scarlet-fever, we require not only energetic contagium, but the presence of persons susceptible to its action, — we have a group of elements capable of such a variety of puzzling combinations, that the wonder is, that we are not oftener left, in cases of this disease, without a clew to unlock the mystery of their origin.

The evidence is often such as to hardly leave room for doubt, that, when not destroyed by adequate means, the duration of the virulence of scarlet-fever germs is to be measured by many months. The "thorough cleansing," alluded to in several of the quotations which we have given, might easily allow a certain number of articles to be overlooked, and so to escape purification. The *destruction* of the contagium of scarlet-fever, either in this country or in Europe,

[1] Michigan State Board of Health Report, 1876.

has been only recently attempted. This subject will be more fully discussed at a later page.

Susceptibility to Scarlet-Fever.

Great differences in the degree of susceptibility in the bodies of different persons, to the action of the poisons of any one of the contagious diseases, are very noticeable. Not all unvaccinated or uninoculated persons become sick with small-pox when exposed to its contagion: yet no well-informed person in these days doubts its contagiousness. Vaccine virus is generally expected to produce, and in the vast majority of instances, when it is inserted in the skin, surely does produce, the vaccine sore and sickness: yet there are some persons, who, although repeatedly vaccinated with carefully-selected virus, have shown no evidence of its specific action. It is very generally known, also, that a person who cannot be satisfactorily vaccinated at one time in his life may, in after-years, show prompt and intense susceptibility to the action of vaccine virus. We also know that after a successful vaccination, the power of the tissues of the body to re-act upon the vaccine matter is lost for a period of years, but may re-appear after a variable interval, as the constitution changes. These familiar illustrations of the varying measure of susceptibility in different persons to specific poisons may help us to understand the apparently irregular and capricious action of the contagium of scarlet-fever.

In what persons, and to what degree, a predisposition to scarlet-fever exists, we cannot always know, although there are certain general rules which help our judgment in this matter. In the vast majority of persons, the liability to this disease is removed in those who have already experienced its action. This is the testimony of nearly all medical observers. It is admitted, however, that the rule has its exceptions. There are very few authorities of modern days, who do not admit the more or less rare liability to a second attack. Still, the class least susceptible to the infection of scarlet-fever, are those who have already had this disease. The class next least sensitive to this infection are those who have passed the age of twenty-five years. The evidence on this point we have already given. This fact is, no doubt, largely due to

the prevalence of scarlet-fever in childhood, owing to which a large proportion of adults are "protected" by having experienced one attack of this disease. Yet this by no means completely accounts for the lack of susceptibility in adult-life; for we find that during the year 1875, when an epidemic of scarlet-fever prevailed in Massachusetts, there were probably 28,066 persons sick with this disease; but at the same time there were in the State 208,709 children under five years of age, and 159,008 children over five but under ten years of age. We find, moreover, that while in the *thirteen years* from 1863 to 1875 there were probably 256,016 sick with scarlet-fever, the number of living children under ten years of age, in the one year 1875, was 367,717. There can be but little doubt that the predisposition to scarlet-fever diminishes with the approach to maturity, and in advancing years, as indicated by the statistics to which we have already referred.

Sensitiveness to contagion, too, may vary in the same individual at different seasons.

Of many cases occurring in adult-life, we know that they reveal a susceptibility to the scarlet-fever poison, which did not exist in the same persons when in earlier years they were thoroughly exposed to this contagion. It has been frequently noticed that a peculiar predisposition to scarlet-fever exists during the prevalence of severe epidemics of this disease. At such times, persons who have previously come in contact with the disease with impunity show an unexpected sensitiveness to the power of its infection. This has given rise to the very reasonable opinion, that the epidemic prevalence of scarlet-fever is due to certain general hygienic influences, which bring the tissues of the body into a condition to receive and re-act upon this poison. Such a susceptible state is produced in the body by other conditions. The puerperal condition has been long observed to expose one to great danger in the presence of the infection of scarlet-fever. So also surgical patients are easily affected by this poison. The general weakness and diminished vitality, or irritability, of the tissues in such persons, render them more susceptible to all contagious diseases.

When we consider the large number of persons in a com-

munity, who, either by reason of a previous attack of the disease, or because of peculiarities of constitution, are protected against the infection of scarlet-fever, we see how the germs may be long passed around from person to person, and deposited in different places, without coming in contact with a body sensitive to their influence, until so far removed from their origin, that to trace the whole course of their wanderings would require superhuman faculties.

General Sanitary Surroundings.

Whether or not the hygienic condition of certain localities has any influence in the propagation of scarlet-fever, is a question much discussed and of great interest. As might be expected from the cause of this disease, its prevalence seems to be much less affected by conditions of soil and sewerage than are the diarrhœal diseases and typhoid-fever. The number of those who think it possible that in some instances the "germs" of scarlet-fever may be generated spontaneously from putrefying animal or vegetable matter is exceedingly small, and their belief is rather speculative than supported by demonstration.

In eleven English towns, during the progress of the works for sanitary improvements "scarlatina *decreased*, and in twelve it *increased*. The average decrease was only 4.31, while the increase averaged 8.85. After the works had been completed, and in operation for from four to eight or nine years, the scarlatina death-rate *increased* in thirteen of the towns, to the amount of 71.26 deaths, giving an average of 5.5 for each town: on the other hand, it *decreased* in ten towns to the amount of 32.57, averaging for each 3.25. . . . At Ashby-de-la-Zouch, . . . before any sanitary improvements were made, the mortality from scarlatina was 0.75; during the works it rose to 10.50; and for ten years after their completion it averaged 8.33. The works effected at Ashby were as follows: "Drying of subsoil, thorough sewerage by pipes; partial substitution of water-closets for middens; an ample supply of water in lieu of bad water from surface-wells, but a few wells still used; better paving and cleansing; no overcrowding at any time."

Conditions of the soil may often undoubtedly exert an influence in determining the mildness or severity of the

disease in different localities. Just as exposure to mephitic and debilitating gases, and the lack of nourishing food, may heighten the sensitiveness of the body to nearly all morbid influences, so may they diminish the power of resistance in human tissues to the poison of scarlet-fever. But as this poison is not dependent upon bad hygienic conditions for its origin, the results of widely-gathered statistics conflict, and at one time show a preponderance of mortality from scarlet-fever in houses with unhealthy surroundings; at another time the so-called healthier districts and homes of the rich are most severely afflicted.

To gain additional evidence upon the point, the following question was proposed to correspondents of the Board: —

Has the extension of or mortality from scarlet-fever been affected by the hygienic conditions of houses or districts or families? Please regard especially dampness of soil, disposal of sewage, crowded population, and deficient nourishment.

Out of one hundred and ten replies, sixty-nine are negative, thirty-five affirmative, and six are doubtful. Those who reply affirmatively for the most part lay particular stress upon the crowding of families into ill-ventilated rooms, and the lack of proper food and nursing. I append a few of these replies: —

Our correspondent from Watertown writes: "I am sure that it has sometimes been affected unfavorably: yet in the majority of instances, bad hygienic conditions have not determined fatal results." From Clinton the answer is: "Yes, particularly by crowded population, as in these cases isolation is impossible; but I have seen some of the most fatal cases in families where the surroundings were what might be called *perfect*, so far as human eyes could discern." Our Becket correspondent says: "Its extension and mortality have been affected mostly by damp situations, small crowded tenements, deficient or improper nourishment, and a want of proper attention to cleanliness." Our correspondent from Lawrence writes: "I am confident that both the extension and the mortality of scarlatina are increased by bad hygienic conditions. Of the four conditions specified in the circular, usually more than one are operative at the same time: consequently it is difficult to estimate the comparative influence of each one separately. Badly nourished children generally live in poor and ill-ventilated houses or tenements, over-populated and unclean; and such cases furnish

the largest percentage of mortality and the most favorable conditions for the propagation of the disease. Unskilful nursing furnishes another important factor in causing a large comparative mortality."

Our Stoneham correspondent writes: "The mortality is undoubtedly greater in overcrowded, unhealthy locations. But in my opinion the mortality is more dependent upon the type of the disease than upon its surroundings." Our Malden correspondent writes: "I am not satisfied that the extension of, or mortality from, scarlet-fever is materially affected by the hygienic condition of districts, houses, and families. I have met with severe and fatal cases as often in dwellings believed to be healthy, where at any rate the location was salubrious, and the premises well kept (I exclude houses in which the presence of the disease at any period recent or remote could be ascertained) as in the home of the poor and squalid, where the simplest hygienic precautions were neglected or unknown. '*Æquo pulsat pede pauperum tabernas regumque turres*,' may be truthfully written of scarlet-fever, especially the malignant form. I do not deny that recovery may sometimes be retarded or prevented by unfavorable hygienic conditions, just as in other diseases it may be retarded or prevented by the same cause. But that there exists any constant and appreciable relation between these conditions and the prevalence of or mortality from scarlet-fever, — that is, any relation which can be demonstrated, and which it is possible to formulate with any degree of accuracy, — has in my opinion yet to be proved. As bearing upon this certainly very important point, it may be mentioned that Malden contains a rather crowded district, almost exclusively inhabited by the laboring class, who are here, as elsewhere, chiefly foreigners. This district, which forms in and by itself a village comprising 150 houses and 1,900 inhabitants (an average of 12.66 persons to each house), is situated on low, marshy, or boggy land, elevated only one or two feet above the level of high tide. The tenements are of the cheap sort usually built for operatives in small manufacturing villages, in whose construction the health and comfort of the occupants is the last consideration. The cellars, when there are any, although usually above ground, are damp at all seasons; and during the spring months many of them are flooded.

"Very little attention is paid to the proper disposal of sewage; the privies are neglected, surface drainage is common; and as for several years water from 'Spot Pond' has been in general use, and the supply abundant, the soil in proximity to many of the dwellings has become water-logged, and its upper stratum con-

taminated by decomposing filth. Add to this that the wages of the laboring class have diminished, that many persons have been thrown out of employment, and a good deal of consequent hardship and privation endured, and we have in combined operation the four important factors in the production of disease enumerated in the circular; viz., 'dampness of soil, disposal of sewage, crowded population, and deficient nourishment.' And yet, during the year ending Dec. 1, 1876, not a single death from scarlet-fever was reported in Malden, although cases of greater or less severity occurred in all parts of the town. Neither has the prevalence of the disease or the mortality therefrom at any time within my recollection been greater on the average within the limits of the above-described locality, than in the more elevated and in all respects more desirable quarters of the town. And what is true of 'Edgeworth,' so called, is true also of several smaller, more crowded, and if possible less cleanly neighborhoods.

"As pertinent to what has just been written, and as an example of the vagaries of scarlet-fever, the following facts may be reported. During the summer of 1867, a child living in one of the worst tenements in Edgeworth sickened of malignant scarlet-fever, and in less than a week died. Beneath the same roof, huddled together in eight small rooms, dwelt five or six families, each blessed with a numerous progeny. The town schools being then closed for the midsummer vacation, the children were all at home, and were permitted, in spite of my remonstrances, to run at will in and out of the sick-room. One day I discovered a group of a dozen youngsters of all sizes and both sexes gathered around a puddle of nasty water fed by the sink-spouts of the premises. They were too much absorbed in the fascinating amusement of making mud, or rather filth, pies from the kitchen sludge, to be either annoyed by the stench, or disturbed by my presence. Now, thought I, for an epidemic; for which, indeed, the conditions seemed exceptionally favorable, — a putrid case, abundance of the right material, crowded quarters, constant exposure, filthy surroundings, a foul and tainted atmosphere: in short, total neglect of all sanitary requirements. Notwithstanding these circumstances, the disease, content for the nonce with a single victim, extended no further in this neighborhood. In fact, so far as I could ascertain by careful inquiry, not another case of scarlet-fever was observed in any part of Malden until the following February, more than six months afterwards.

"In view of these and similar facts which every practitioner of experience must have encountered, I think it will generally be conceded that ordinary hygienic measures and sanitary precautions

fail to prevent the outbreak, or to arrest the spread, of this disease."

The conclusions to which their personal observations in different sections of the State have brought our correspondents go to confirm the belief, that the prime elements in the production of scarlet-fever are a specific contagion, and susceptibility to its action. With this understanding of the origin and spread of this disease, the very occurrences so many have borne witness to are to be expected; viz., the failure of insanitary surroundings to beget the disease, or to insure its extension when it has been once introduced, and the occasional preponderance of fatality from scarlet-fever among the homes in a community best protected against the ordinary causes of sickness. The susceptibility to the poison of scarlet-fever seems an inherent property of the vast majority of human constitutions. It may be retained with the highest measure of health and perfection of development. Indeed, it is sometimes those who are apparently exceptionally healthy, whose systems may be most intensely disturbed by the poison.

No degree of care to observe, and no abundance of effort and means to provide, the most approved conditions for securing robust health, seem, in any case, able to remove the sensitiveness of human tissues to the contagion of scarlet-fever. Hence even those whose dwellings are exceptionally favorable to health, may at some seasons be as susceptible to infection, or even more so, than others, who at the same season are exposed to sicknesses of various kinds, in dwellings surrounded by all manner of uncleanness.

In forming our opinion concerning the relative prevalence and mortality of scarlet-fever, among those two extremes of society whose surroundings generally represent conditions favorable or unfavorable to health, two considerations may well be kept in mind. *First*, that the children of the poorer classes are more exposed to the causes of other fatal diseases, such as cholera-infantum, diarrhœa, dysentery, typhoid-fever, and various affections of the throat and lungs; and that, from these sicknesses, thousands of them die, who are thus taken beyond the reach of the action of contagious diseases. Therefore the proportion of deaths from scarlet-fever to

deaths from all causes, may at times appear much smaller among the poorer than among the richer classes. The *second* consideration is to the effect that "among the poor, the deaths follow the primary disease after a very considerable interval of time, and appear under other names in the mortality report."

These considerations will in part explain those variations (which statistics of scarlet-fever sometimes seem to approve) from the general rule, that insanitary surroundings favor the spread and fatality of morbid poisons.

So far as we can learn, the hygienic conditions which most affect the extension and severity of scarlet-fever are, first, density of population, which brings a larger number in contact with the contagion; second, all other circumstances, whether of location, sewerage, method of life, or kinds and amount of food, which may add their debilitating influences to the devitalizing effects of the scarlet-fever poison.

Influence of Schools, &c.

From what we have thus far observed concerning the circumstances which favor the extension of scarlet-fever, we very naturally infer that any institution which occasions the congregating of children, such as our day and sabbath schools, and academic institutions, may at times occasion a wide distribution of this infection. Aitken, Murchison, Thomas, and most other good authorities, hold this view; and abundant facts are recorded in support of it.

To learn the result of the observations of physicians in our own State upon this point, the following question was asked of our correspondents: "Have you had reason to believe that the infection of scarlet-fever has been disseminated by the association of children in your schools?"

Of eighty-five replies to this question, fifty-eight are affirmative, sixteen negative, and eleven are indecisive. Those who reply negatively simply affirm that they have witnessed no instances which proved that the contagium has been disseminated by the schools with which they have been acquainted.

Some of the evidence furnished by our correspondents is as follows: —

Dr. Belden of Springfield writes: "The first case in town this year was very mild, and was sent to school too soon after recovery. The fever then broke out in another girl, sitting next this first one, and soon after in others. In each family attacked, it appeared first in a young girl attending this same schoolroom. The children attending other schools have not suffered; and in each case it seemed to originate from the girl's side where the first patient sat, although it afterwards spread in the different families these girls represented; still no families suffered except those having young girls in this schoolroom."

Dr. Cutter of Waltham writes: "I have just now a small group of cases which I trace to a child who attended school while the skin was desquamating. The child was only slightly ill, and was not attended by any physician."

Dr. Springer of Yarmouth writes: "In the epidemic of last spring, it began in our primary schools, and new crops of cases would occur quite regularly every two weeks."

Dr. Ames of Wakefield says: "I consider nothing so effectual" (as the association of children in schools) "in spreading it" (scarlet-fever) "except crowded tenements. I have known a single case brought to a school from another town, after partial recovery, and an epidemic to follow, although other schools were exempt even in the same building."

Dr. Gleason of Rockland writes: "In one of our schools, a year ago, some three or four came down with the disease; and I found that a child having had the disease lightly had returned to school before desquamation was complete."

Dr. Howes of Hanover writes: "Two years ago the disease was confined to one district for two months; and almost every child in the school had either a well-developed scarlatina or something kindred to it."

Dr. Winsor of Winchester writes: "I have twice seen it prevail in certain school districts, when there was scarcely any other case in town; and to a degree which did not seem accounted for by the neighborhood relations."

Dr. Soule of Winthrop writes: "A few years since, a family came into this town, and sent their children to school; very soon one of them came down with scarlet-fever. Within four weeks nearly one-half the school had the fever."

Dr. Haskell of Rockport writes: "I have reason to believe that it" (viz., the association of children in our schools) "is one of the most frequent sources of infection. I have repeatedly had cases traceable to the return of children convalescent from the fever to school." "A child had had scarlet-fever: soon after her

return to school, the two children who sat next to her, one on each side, were taken with it; and these three were the first cases that happened in town at that time."

Dr. French of Warwick writes: "Of late we have had no epidemics of this disease; but in my practice of thirty-two years I have known many schools to be broken up by the presence of scarlet-fever. In the epidemic that raged in Winchester, N.H., where I then resided, in 1864–65, there were only a few cases in one family before the school commenced; one of the children of this family attended school: in a short time one-third of the school were affected."

Another correspondent writes: "I have no doubt that scarlet-fever has been disseminated by the association of children in our schools. Children have been sent to school, wearing the same clothing they wore when sick, and before the desquamation was completed. We have some families in this town who hardly know soap and water."

Dr. Sullivan of Malden writes: "It is a common remark of parents, and my own observation confirms the statement, that 'children begin to have contagious diseases as soon as they are sent to school.' That this is true not only of measles, varicella, and whooping-cough, but of scarlet-fever also, I do not hesitate to affirm. I recollect several epidemics confined chiefly to the pupils of a single school; and on several occasions, one or more of the public schools have been temporarily closed, by order of the school committee, in consequence of such outbreaks. In short, it is my conviction that a large proportion of the scarlet-fever cases occurring in Malden in any given year originate either directly or indirectly in the schoolroom. A simple illustration will suffice. Nov. 1, 1876, A. B. aged six, sickened of scarlet-fever. Exactly two weeks before the attack, attendance on school was resumed by a companion who usually occupied an adjoining seat, but who had been detained at home for some time by the same disease. When she came back, my informant declared, 'the skin was all peeling off her hands.' This is not a solitary case. Hundreds of children throughout the Commonwealth are subjected, in the course of every year, to just such unnecessary, indeed, little less than criminal, exposure. Stringent measures are required for the protection of the young, whose health and lives are thus wantonly endangered and not seldom sacrificed."

To obtain further information upon this point, circulars were sent to the superintendent of schools, or chairman of the school committee, in each city or town with upwards of

three thousand inhabitants. These circulars asked, among others, the following questions : —

"I. What is the whole number of pupils in your schools?

"II. Can you tell approximately, if not exactly, how many of these have been sick with scarlet-fever annually? [If any record has been kept from which this question can be answered for a series of years, we should like the recorded number of scholars and cases of scarlet-fever for each year. If there is no record of sickness kept, please secure, as well as you can by inquiries through the teachers, the whole number of cases for the year about ending.]"

Replies to these circulars showed that scarlet-fever had not existed to any great extent in the schools reported, during the past year (1877), and that, owing to the fact that teachers are rarely if ever required to make a record of the special sickness of their pupils, no reliable data existed by means of which to determine the exact degree to which it had prevailed in past years in different schools.

To the question, "Have you had reason to believe that the infection of scarlet-fever has been disseminated by the association of children in your schools?" the answers for the reasons above stated were, with few exceptions, negatives. Some gave as a reason for the negative reply, the fact that but little scarlet-fever had existed in their community; others, that while it had existed they had not watched its course critically enough to be able to answer affirmatively; others, that its apparent failure to spread in the schools was due to regulations which excluded pupils from attending school from houses where any infectious disease existed; others, that while no local law forbade pupils to come to school from houses infected with scarlet-fever, a wholesome dread of this disease in their community led parents of the sick, of their own accord, to keep their children from mingling with others until permitted by their physician to do so. One affirmative reply is in the following words: "Only one instance is known: in that a child attended school during an attack so slight that the parents said they were not aware of the nature of the case, and had no physician. About six cases were traced to this source of infection." The experienced superintendent of schools at Springfield writes: "Unquestionably it" (scarlet-fever) "has" (been disseminated in schools) "in some

cases." Another replies: "In two cases;" another, "Yes, in past years;" another, that "one district school was broken up for a week by parents keeping their children at home."

A fourth question in the above-named circular was as follows: "To what degree has the presence of scarlet-fever in your city or town diminished the attendance of pupils in your schools?"

Owing to the absence of school records of special sicknesses among pupils, it has been difficult to distinguish the disturbance of schools occasioned by the prevalence of scarlet-fever from the disturbance created by other illnesses. Hence school officers are obliged to speak cautiously on this point. Seventeen out of thirty-six respondents have observed a diminution of attendance on the schools, varying from one to ten to twenty per cent, and even to the breaking-up of a school for a season; while others, owing to the slight number of cases in their respective communities, have witnessed no perceptible interruption of the attendance of pupils by reason of scarlet-fever. But we are to bear in mind that the evil done by the careless transmission of infection from one scholar to a few others in a school is not indicated by the ratio of the six or twelve who sicken, to the fifty or one hundred who attend the same school, and remain well. The small group of affected children may not very perceptibly diminish the attendance at a particular school; but each one of the sick is likely to carry the infection home to children too young to attend school, and of ages most unfavorable for successful resistance to the disease.

Incubative and Infective Period.

Two characteristics of the action of the "contagium" of scarlet-fever need careful consideration before we pass to speak of rules and methods to be observed to restrict the spread of this disease. Before we can say when it is safe for one who has been exposed to the infection of scarlet-fever to mingle again with persons unprotected against its influence, we must learn as nearly as possible the so-called "period of incubation" of this poison, or, in other words, the length of time which may pass between its reception into the body and the manifestation of symptoms of its action. Moreover, to

know when to permit those who have been sick with scarlet-fever to associate with others susceptible to its contagion, we must ascertain at what period during or after convalescence such patients cease to communicate infection.

Period of Incubation.

In determining the period of incubation, caution must be exercised to select those cases in which the precise time of infection can be determined. Where this rule has been regarded, the period in question seems comparatively short, and varies from a few hours to seven days. In other cases, in which the latent period appeared to be several weeks, as in two cases related by Dr. W. M. Saunders,[1] R.N., which occurred at sea, at no less than fifty-one and fifty-four days, respectively, after exposure, we question whether it is not much more probable that the infection was carried in some one of the personal effects of such patients, and taken into the system through the lungs and stomach a few days before the appearance of the characteristic symptoms.

Trousseau[2] narrates the following incident: "A London merchant had taken one of his daughters, and passed the winter at Pau in France. On his way back to England he stopped at Paris. . . . His eldest daughter was keeping house for him in London. Impatient to embrace her father and sister, she started for Paris. When crossing the Channel she was seized with fever and sore throat, and seven or eight days later arrived at Paris in the middle of a very serious attack of scarlet-fever. She alighted at the hotel almost at the very moment when her father and sister arrived from Pau. The two sisters remained together in the same room; and in twenty-four hours the sister who had come from Pau showed the first symptoms of a mild attack of scarlet-fever. In London the disease was then epidemic; but there were no cases at Pau." He adds, "This curious history proves that in scarlet-fever the duration of the period of incubation is sometimes not more than twenty-four hours." Dr. Murchison relates the circumstances connected with two cases of scarlet-fever in which he was able to fix the time of infection, and in which the latent period was less than twenty-four

[1] Hillier on Diseases of Children, p. 298.
[2] Trousseau's Clinical Medicine, vol. ii. p. 165.

hours. The same author gives the particulars of eleven other cases, in which the time between infection and the outbreak of the disease was definitely determined to be from less than twenty-four hours to six days.

Dr. Richardson, who was a pains-taking student of this disease, and himself so peculiarly sensitive to its poison that he thrice suffered from its attacks, relates that "he had applied his ear to the chest of a patient suffering from scarlet-fever, and was conscious of a peculiar odor emitted by the patient. He immediately felt nauseated and chilly, and from that moment he was able to date the commencement of his illness." Referring to this case and his own, Dr. Murchison concludes that "the latent period of scarlet-fever varies from a few minutes to five days, and that it rarely, if ever, exceeds six days." Other authorities state that the period of incubation varies from a few hours to six days; from a few hours to ten days; from two to fourteen days. In many cases, it has been apparently extended to three or four weeks. From a comparison of many authorities, we find the average duration of the latent period to be about eight days.

To ascertain what had been the experience of physicians in different parts of our own State in this matter, correspondents of the Board were asked to state such facts as they were able, to indicate the shortest and longest period of incubation of scarlet-fever.

Their opinions based upon personal observations show how difficult it is to state the precise limits of this period. While its ordinary duration may not exceed a week, it is not yet clear how much beyond this point it may be prolonged.

It is evident that much of the difficulty in the way of learning the greatest possible length of the period of latency is due to the presence of sources of error which it seems now impossible to exclude. Of several persons exposed through several weeks to the same source of infection, one may receive the poison at once into his system, and sicken with the fever within seven days; another may receive the poison upon his person or clothing, but escape the contact of the infection with any absorbing surface for several days or weeks, so that when after a week or a fortnight the poison

enters the system, and thereafter occasions the usual symptoms in seven days, the period of latency will appear to be prolonged to a fortnight or three weeks; another, when first exposed, may not be susceptible to the disease, but become so as nervous fatigue, or disturbance of digestion or of other functions, or changes in his previous hygienic circumstances, modify his constitutional powers of resistance to morbid poisons.

Duration of Infective Period.

The question, at what period during and after his illness a scarlet-fever patient begins and ceases to evolve contagion, also admits of only an approximate answer. An opinion that the infection can be communicated during the period of latency, — that is, previous to the outbreak of the initiatory symptoms of the fever, — is as yet speculative and unproven. There is, however, abundant evidence, that, from the first symptoms of the fever to the completion of the desquamation, the poison of the disease is developed in and emitted from the patient. The time when the fever may be *most* contagious appears to be the days, in any individual case, during which morbid action gives rise to the most abundant excretions from the throat, nasal passages, lungs, stomach, and skin. The length of this time will depend upon constitutional peculiarities, combined with all other conditions and influences which may hasten or protract recovery.

Dr. Watson honestly says to his pupils: "You will be asked at what period the danger of imparting the disease on the one hand, or of catching it on the other, is over; and I would recommend you to answer, that you do not know."

To gather evidence upon this point, correspondents of the Board were requested to state such facts in their possession as would "indicate the earliest and latest stage of the disease at which it might prove contagious."

The cases cited in their replies well state the difficulties which beset this question, but confirm the generally-received opinion that the danger of contagion persists until desquamation is completed.

These testimonies show so great variableness in the period of desquamation, that any term of isolation of a patient suf-

ficiently long to cover all possible prolongation of the period of infection would be extremely burdensome to the vast majority of persons who could safely return to society much earlier. The infliction of so great a hardship might be avoided by a law which should *require* the exclusion of scarlet-fever patients from society for *at least four* weeks from the commencement of the attack, and for as long a time beyond that period, until the attending physician should certify that it was quite safe to return.

Summary of Evidence.

From the foregoing examination into the methods and circumstances in which the contagium of scarlet-fever manifests its action, we have seen, —

1st, That, in invisible and impalpable quantity, it may induce the fever in susceptible persons.

2d, That it multiplies itself to a profuse degree in the bodies of those it infects.

3d, That it exists largely in the vapory exhalations and various fluid and solid excretions from the bodies of the sick.

4th, That it may retain its power of infection for a long time.

We may reasonably infer, —

5th, That it is particulate.

6th, That it is capable of exceedingly minute subdivision.

7th, That it has a very light specific gravity, so that it can be sustained in vapor, and carried certain distances by a current of air.

8th, That it is very tenacious.

9th, That it is not volatile; for which reason, while adhering to garments or other articles, it does not evaporate from them.

These characteristics not only explain how the infection of scarlet-fever has extended itself in individual instances; but they suggest how various conditions and customs of society are likely to favor the distribution of this poison, and what must be the character of the attempts to neutralize its power.

Restrictive Measures.

Are there any agents or methods by means of which it is possible to greatly restrict if not to completely control the

spread of scarlet-fever? To this question we receive such encouraging replies, that the unmolested prevalence of this dreaded pestilence seems a not less censurable than lamentable occurrence. There are obviously two principal methods by which we must contend against the propagation of this disease. By one we seek to chemically change or destroy its infectious matter; by the other we seek to restrict its diffusion.

Disinfectants and Deodorants.

The first method involves the selection and use of chemical agents called, by reason of their action, disinfectants. Enumerated under this name there is a large number of elements and compounds with very different properties.

In considering what agents may be used to destroy the contagious properties of infectious particles, we must bear in mind the difficulty of bringing these particles and the disinfectants in contact. The infection of scarlet-fever is to be found not only in vessels which receive the discharges of the sick, where it can be easily treated with concentrated-solutions of chemicals; but it is also widely distributed throughout the air of a room or house, and lurks in the crevices of walls or furniture, or in the meshes of carpets, bed-clothing, and garments. We need, therefore, beside disinfecting solutions, with which infected matters or articles can be washed or drenched, or in which they can be soaked, disinfecting vapors or gases, to penetrate every space, however minute, in which contagion may be concealed. Here, another troublesome circumstance meets us, in the fact that gases sufficiently strong to thoroughly disinfect an apartment cannot with safety be inhaled. Therefore, during the sickness of one ill with scarlet-fever, we must be content with partial destruction of the infection he produces, and reserve the use of more active agents until his room can be for a time vacated. We shall find it convenient to divide the disinfectants into two classes; viz., (1) those which may be used during the occupancy of the room by a patient and his attendants, (2) those which should be used only after the room is vacated.

Chief among those of the first class, is pure air, secured by free ventilation. At the same time that it dilutes, it may oxidize infectious particles. Several observers have re-

marked that the contagion seemed most active in garments or other fomites, by means of which it was confined and excluded from the air. Other agents of the first class are strong solutions which may be placed in the vessels which receive the discharges of patients. Of these, there are several; the following appear to be the most reliable: saturated solution of carbolic acid, solution of permanganate of potash,[1] solution of chloride of zinc,[2] solution of sulphate of zinc, and combinations of these solutions. The first solutions can be added to the water used to sponge the body of the patient, or to wash the hands of attendants. All of them can be added to water used to cleanse the floor, furniture, or washable articles used by the patient, or the water in which infected cloths and clothing can be soaked previous to washing. Boiling water will thoroughly disinfect clothing submitted to its prolonged action.

But no measures will avail to destroy the contagious matter attaching to rooms and furniture infected with the poison of scarlet-fever, until we can use chemical agents as destructive to human life as they are to infectious matter. Chief among these agents is heat. "Henry[3] caused unaffected children from six to thirteen years of age, to wear the flannel jackets of scarlatinous patients, after these garments had been subjected to a dry heat of 212° Fah.: notwithstanding the facility with which the contagion is carried by woollen garments, no infection followed." Dr. Henry concluded "that by exposure to a temperature not below 200° Fah., during at least one hour, the contagious matter of scarlatina is either dissipated or destroyed." The same fact, Thomas states, "according to Behrend, was proved in Berlin, where the garments were kept in a close and heated chamber until it had cooled, with the result of destroying the vitality of the poison." Dr. Bell[4] gives the results of his own practice in disinfecting vessels, which show that heat is no less efficacious in the form of steam or hot water, than it is in dry air. We shall find further confirmation of

[1] Condy's Disinfecting Fluid contains 9.26 grains permanganate of potash to the fluid ounce.

[2] Burnett's Disinfecting Fluid.

[3] Medical Times and Gazette, Sept. 23 and 30, 1871; pp. 374, 401. Braithwaite's Retro., January, 1872, p. 252.

[4] Dr. Bell on Disinfectants.

the disinfecting power of high temperatures, when we come to speak of the methods in which they have been applied.

Other energetic disinfectants, so-called, are nitrous acid gas, ozone, chlorine gas, and sulphurous acid gas. These all must be used in quantities too large to admit of their employment in an occupied room. Concerning nitrous fumes, produced by the action of nitric acid on copper in the presence of air, we learn that these fumes were found by a special commission of the French Academy of Sciences, to be more powerful than chlorine as a destructive disinfectant. . . . They are very poisonous, and must be used with great caution. Ozone has been less largely used; for to prepare it in sufficient quantity proves much more expensive and troublesome than some other disinfectants, over which it perhaps possesses no advantages. Chlorine gas is thought by some to be one of the most active disinfectants; but to act as thoroughly as possible, it must be applied to infected apartments or articles *in large quantities, and for a long time.* It requires great caution in its use, and is objectionable by reason of its bleaching properties, and its corrosive action on metals. Sulphurous acid gas is one of the cheapest, most easily procured, most manageable, and efficient disinfectants.

The fumes of volatilized bromine and iodine may also be used for disinfection; but they are less available and more expensive than other equally useful and common chemicals.

Since the chemical nature of the infectious matter is not precisely known, experiment alone must determine what agents will change its character. But, whether it be an albuminoid organism, or a purely chemical compound, it appears to undergo a change in its properties by combining with, or being split up by, the powerful oxidizing agents we have mentioned, for by their use the communicability of the disease is at least very much diminished.

Methods of Suppressing Scarlet-Fever.

To present in more practical form the combination of the two methods for suppressing the extension of scarlet-fever, let us inquire what should be our method if required to give directions for the management of a case of this disease, observing only necessary precautions. Having seen premonitory symptoms such as feverishness, sore throat, and nausea,

which lead us to think that we have this contagious disease to treat, we seek to ascertain, *first*, how many children are in the family; *second*, how many of them have within a few days kept company with the one who is ill. If any are away from home, they should, if possible, be prevented from returning for several weeks. If any have had little or nothing to do with the patient for many days, they should be kept from those, if there be any such, who have been very intimately, frequently, and recently, in contact with the sick one, and are therefore more liable to the disease.

We seek next to *provide a suitable room.* This should, if possible, be in the upper part of the house, with facilities for good ventilation. An open fireplace in the room is most desirable; but, if this cannot be arranged, an opening may be cut into the chimney. To secure a thorough renewal of the air, the windows should be kept freely open in warm weather, with care to check draughts across the patients. In cold weather, boards four inches wide, and corresponding in length to the width of the windows, can be placed on their sides beneath the lower sashes; air will then enter the room between the sashes, without creating direct draughts. If it be noticed, that, when the door of the room is opened, the currents of air pass outward, it will be necessary to arrange a simple frame of the same width as the door, which can be fastened to the upper part of the outside frame of the door, so as to project from fourteen to eighteen inches. The top of the frame should be covered with cotton cloth; a sheet should then be fastened to its front and sides, so as to hang like a curtain to the floor, forming thus a tent-like vestibule. Both the covering-cloth and sheet-curtain may be dampened with a disinfectant. The curtain should not be put aside while the door is open. The door should be kept closed except when opened to permit one to pass from or into the sick-chamber. It is desirable to have in connection with the sick-room, an ante-room, where those who attend the sick can lay off or put on clothing which they do not wear into the infected air, and where small tubs, buckets, or other vessels, containing disinfected clothing or slops, can be brought, previous to their removal and return, by persons who do not more directly serve the patient. The door into this ante-room should be kept closed, and, if the direction of

air-currents require it, should be trapped with a tent-like vestibule, such as we have proposed for a door leading into a public entry.

Particular attention should be given to *the preparation of the room.* All upholstered furniture should be removed. If this cannot be done, such furniture may first be covered with large sheets of paper pasted at the edges (newspapers will answer), while over the paper there should be put a covering of closely woven cotton cloth. The coverings should be so applied to sofas or chairs as to catch all dust that might incline to fall into the spaces between their sides or back and seats. If the carpet cannot be removed, it should be protected in a similar manner. If the carpet be removed, it will still be well in most instances to use protective coverings of paper and cloth, to keep infectious matter from being deposited with dust in the cracks of floors. At the conclusion of the sickness, the cotton coverings can be carefully folded inward as they are removed, and placed first in a tub with a solution of disinfectants, before they undergo complete disinfection by prolonged boiling in water. The papers can be burned. All woollen hangings, and coverings of tables, and painted window-shades, should be removed, and replaced with sheets or towels or cotton cloth, that can be easily washed. All unnecessary decorations or other articles should be removed from exposed shelves or mantles, or, if too large to be removed, should be carefully protected with washable coverings. If a closet connected with the sick-chamber is to be used, it also should be divested of all articles which are not to be used during the sickness. If this cannot be done, it will be better to close and lock the closet-door to prevent its use.

Those who are to attend one sick with scarlet-fever should select, to wear in the presence of the patient, cotton or linen wrappers or gowns. Garments worn in the sick-room should not be worn beyond this room or the ante-room we have mentioned, nor should they be taken beyond these rooms, until they have been immersed in a disinfectant solution. Persons in attendance upon the sick should not visit other rooms in the house, notwithstanding they may have used the precaution to change their clothing. They should not be permitted to use the kitchen. The food needed for nurse

and patient should be brought to the ante-room, or placed in the vestibule. When the condition of the patient allows, or an assistant can attend to his wants, the nurse should take daily exercise in the open air, with care to avoid public conveyances, houses, the company of children, and public gatherings. Immediately after handling the person of the patient, or cloths or utensils soiled with his discharges, attendants should wash their hands in some disinfecting fluid. At the termination of their service, before mingling with other persons, nurses should not only change their clothing, but bathe their persons, giving special heed to the thorough cleansing of their hair.

The measures for disinfection to be used by the nurses are as follows: First, Under direction of a physician, the body of the patient can be kept thoroughly anointed with some emollient ointment[1] or oil which will not only allay the irritation of the skin, but will fix the fine flakes and excretions of the skin, so that they can be sponged from the body with water containing some disinfectant, or so that they will adhere to the clothing, which can be daily removed, immersed in solutions of disinfectants previous to boiling, and replaced with fresh dresses. Second, All vessels which receive the expectorations or other discharges of the patient should contain a liberal quantity of strong disinfecting fluid. The mattress or upper bed should be covered with a rubber blanket, and this in turn with a woollen blanket. A rubber cloth should cover the floor by that side of the bed on which the sick one lies. From this rubber cloth, all accidental discharges as soon as they fall should be sponged with disinfectants. Pieces of soft cotton cloth should be used instead of handkerchiefs, and be burned as soon as soiled with discharges from the mouth or nose. The sheets should be changed at least every other day.

A small tub, containing water holding disinfectants in solution, should be at hand to receive all cloths which are to be washed. Soiled bed and body clothing, towels, and all clothes which require cleansing, should be first immersed in this tub. The vessels from which the patient eats and drinks, the nurse should cleanse and rinse with disinfectants before

[1] Cosmoline, vasoline, and dermoline, new preparations from the distillation of petroleum, will prove convenient for this purpose.

they are taken from the room. Uneaten portions of food, which has been brought into the sick-chamber, should be put with the slops, and treated with disinfecting fluid. Books, toys, papers, or other articles used by the patient, should not be taken from the room before being disinfected; and all of such articles which cannot easily be disinfected should be burned. Although, as we have seen, but little disinfectant action can be expected from such a quantity of vaporized chemicals as can be safely diffused through air which is to be inhaled, it may nevertheless be well to use the chloride of lime, or cloth wet with a solution of nitrate of lead and suspended in the room, or small quantities of iodine vaporized according to Dr. Richardson's method, to destroy mephitic and debilitating odors. If the above precautions are observed, the room will hardly need frequent sweeping. When, however, it is swept, saw-dust dampened with a strong solution of carbolic acid may be scattered over the floor, previous to using the broom. The sweepings should be burned, and the broom disinfected. Great care should be exercised in disposing of the discharges of the patient, and of all "slops" from the sick-room. They should be promptly removed. They should first be liberally drenched with a disinfecting solution before being cast into a water-closet leading to a public sewer. If there is no public sewer, they should be buried in the ground at a distance from any well. On no account should they be thrown on any ash-pit, dunghill, or into any cesspool.

Cloths and clothing requiring washing should be taken to the wash-room, without being carried into the presence of children or other susceptible persons. They should at once be transferred into boiling water in a boiler which has an escape-pipe into the chimney, and which can be closely covered. After boiling for between one and two hours, they should be washed and thoroughly aired. No washing from the sick-chamber should be mixed with the general washing of the family, or sent to a public laundry.

The only visitors admitted to the sick-room should be the doctor, rarely the clergyman, and some near relation like a father or mother. It may seem superfluous to add that all these persons should use the greatest caution to avoid carrying the disease. They should not handle the patient nor his

surroundings needlessly. They should wash their hands in some disinfectant before they go. They should not stay long. They should walk in the open air before going to other susceptible persons. It is a good recommendation, that physicians should visit other children, and puerperal or surgical cases, before rather than after their visit to a child with scarlet-fever. No domestic animals should be allowed to enter the rooms used by the patient or his attendants.

Of the various methods of preparing and applying disinfecting solutions, the following appear to be the most approved: —

The Health Department of the City of New York recommend the following as a good fluid with which to disinfect cloths and clothes, and to put into vessels which are to receive slops, or the discharges of the patient, or to turn down water-closets or privies to destroy contagion: "Eight ounces of sulphate of zinc, one ounce of carbolic acid, three gallons of water." Clothes "should be soaked in this fluid for at least one hour, and then placed in boiling water for washing." The same Board commends as a good substitute for this fluid, with which to disinfect water-closets and privies, "a solution of chloride of iron, one pound to a gallon of water, adding one or two ounces of carbolic acid."

As a disinfectant of clothing, carbolic acid is objectionable, both on account of the weakness of the solutions which it is safe to use, and on account of its most persistent and to some very disagreeable odor.

Dr. Baker, Secretary of the State Board of Health of Michigan, recommends chlorinated soda as "the neatest and most convenient" agent to use to destroy the contagion in clothing, "because it can be used with soap;" but he adds, "it is apt to lose its disinfecting properties by age."

As an odorless disinfectant with which to cleanse the hands, or sponge the body of the patient, the solution of permanganate of potash is one of the best.

During convalescence the patient should keep in his own room until "desquamation" is completed. After complete recovery, he should not mingle with the rest of the family, or go about the house, until he has been thoroughly bathed, his hair has been thoroughly cleansed, and his person clothed in fresh uninfected garments. The premises he has occupied

should then be disinfected in the following manner: The coverings upon the carpets and furniture, the temporary curtains, and the bedclothing, should be carefully folded inward as they are removed, so as to retain whatever of contagion may be upon their exposed surface. They should then be put into a tub containing some disinfecting fluid, preliminary to boiling and washing. The bedding, furniture, and all articles in the room, should be so opened or arranged "as to expose the greatest amount of surface to the action of the disinfectant." All outlets from the room, such as the chimney-flue, windows, &c., should be closed. The fumes of sulphurous acid gas should then be generated in the room by burning sulphur on live coals. There is no danger in using an excess, for the sulphur will go out in a well-closed room, when the oxygen of the room is consumed. The person using this disinfectant, immediately after lighting the sulphur, should withdraw from the room, and close the door. It is advised to keep the room closed from six to eight hours. At the end of this time, the windows should be widely opened, and the air and sun allowed to search and purify the room of its offensive odors or remaining infection.

All the wood-work, furniture, and fixtures of the infected rooms, should be washed with water containing a solution of chlorinated soda [1] or of carbolic acid. If the former is used it may be mixed in the proportion of one part, by measure, of the solution, to five parts of water. After the first thorough washing of the room and furniture, the water and cloths which have been used for this purpose should be treated with an additional amount of disinfecting fluid; and the room may be a second time sponged with a clean saturated solution of carbolic acid.

Should a death occur from scarlet-fever, arrangements should be made for an early burial. The infected clothing should be stripped from the body, and put into disinfecting fluid. The body should be thoroughly cleansed by washing with a solution of chlorinated soda; [2] it should then be wrapped in a folded sheet which has been saturated with and wrung out from disinfecting fluid. The undertaker should be

[1] Labarraque's Disinfecting Fluid.

[2] For this purpose Dunglison recommends one pint of Labarraque's disinfecting fluid, to two quarts of hot water.

directed to make the bottom of the coffin water-tight, and to cover it with a layer of sawdust six inches deep: this sawdust may then be thoroughly dampened with a solution of chloride of zinc[1] or with the disinfecting solutions already mentioned. The body may then be bedded in the sawdust. The coffin should be permanently closed in the room where the patient died. The nurses should prepare the body for burial. The undertaker should be present only a sufficient time to deposit, close with screws, and bear away the coffin. Before its removal the attendants and undertaker should cleanse their hands in disinfecting fluid; then with a clean sponge or cloth wet in disinfecting fluid an attendant should wipe over the outside of the coffin directly before the undertaker bears it from the room. Undertakers should not furnish ice-chests to be used for persons who have died of some contagious disease. No attempt should be made to long postpone burial. Neighbors and friends should not be admitted to the house to attend the funeral, which should be brief, and conducted so as to give the least possible opportunity for the communication of infection.

Difficulties in Complete Disinfection.

As we have enumerated the various details which it is necessary to observe, to limit the transmission of contagion, a discouraging number of difficulties in the way of carrying out such provisions suggest themselves. These difficulties may be broadly classed as due to physical and moral causes. An examination of some of those which appear the most formidable will show that although they cannot easily be completely set aside, they are by no means insuperable. Among the physical obstacles, are the lack of house-room in some tenements to admit of isolating the patient; the lack of opportunity for proper ventilation; the inability to secure nurses who can keep aloof from other persons, and give their whole time to the sick; the lack of means to provide or to properly cleanse the necessary changes of clothing; and the inability to control the best means of disinfection. It is clear that these difficulties can only be thoroughly met by public hospitals for this, as well as other contagious diseases, by the provision of public apparatus for disinfec-

[1] Burnett's Disinfecting Fluid.

tion, and by provision for a public supervision and execution of the details of disinfection. Although we may do much among the classes who have moderately ample accommodations and means for living, to restrict the spread of scarlet-fever, we cannot hope to succeed in stamping it out as effectually as possible until public authority takes firm control of the disease *at its first outbreak*, and *provides* isolation and disinfection where private resources are insufficient for these purposes.

Speaking upon this point, Mr. John Simon in his "Twelfth Annual Report"[1] as Medical Officer of the Privy Council of England says: "If scarlatina and the like diseases are to be stopped, *first let certain local facilities for dealing properly with dangerous infective diseases be claimable within every health jurisdiction in the country*, — facilities which are hitherto almost universally non-existent among us; and then let the authority of every such jurisdiction be by law required to take definite precautionary means against the diffusion of such diseases. It would be needful, and, for the purpose in view, would require to be made a legal obligation, *that every health-authority of the country should have sufficient, proper, and permanent hospital accommodations for cases of infective disease* arising within the jurisdiction, and should have all disinfectant processes necessary for protection of the public health done under direction of a skilled officer, and, as far as necessary, at a public establishment, and at the public cost; and should take the initiative in enforcing, as regards sick persons and dead bodies, and infected things, such several rules of conduct as universal experience dictates, to prevent the wanton spreading of diseases."

Hospitals for Infectious Diseases in Great Britain.

We find that in England great success has attended attempts to furnish hospital accommodations for scarlet-fever. From the Report of the Committee of Management of the Metropolitan Fever and Small-pox Hospitals at Homerton in the parish of Hackney, dated January, 1876, we learn that the hospitals were completed in December, 1870. They "are designed on the pavilion principle, and that for fever consists of five blocks for patients, containing, in all, two hundred

[1] The Italics are ours.

beds, which are nominally allotted to the various forms of fever, as follows: " —

Typhus, 6 wards, 18 beds in each, 2,000 cubic feet allowed to each case	108 beds.
Scarlet, 2 wards, 18 beds in each, 2,000 cubic feet allowed to each case	36 "
Enteric, 2 wards, 24 beds in each, 1,633 cubic feet allowed to each case	48 "
Special Cases, 2 wards, 4 beds for males, and 4 for females .	8 "
Total	200 "

The small-pox hospital has four blocks for patients, and provides for 102 cases.

" The fever hospital was opened for the reception of fever cases on the 1st of October, 1871, and it received cases arising in every parish and union in the metropolis, until the 30th of June, 1872, when the Stockwell Fever Hospital, which had been previously used for the treatment of small-pox, reverted to its original purpose." That the hospital has been very usefully employed, is shown by the fact " that 3,390 patients have been admitted, of whom " —

528	suffered from		typhus-fever.
884	"	"	enteric-fever.
1,042	"	"	scarlet-fever.
378	"	"	simple continued fever.
550	"	"	various ailments, classed in the statistics as other diseases.

" Of this number 601 died, the deaths being distributed as follows: " —

114 typhus cases,	being	a	mortality	of	21.5	per	cent.
153 enteric	"	"	"	"	17.3	"	"
144 scarlatina	"	"	"	"	13.8	"	"
190 other diseases	"	"	"	"	34.0	"	"

Also 171 cases of scarlet-fever were treated at the small-pox hospital, to which allusion has been made.

According to the Report of the Chairman of the Metropolitan Asylum Board of London, during the four years 1872, '73, '74, '75, there were treated in Homerton Fever Hospital 1,046, Stockwell Fever Hospital 978, and in Homerton Scarlet-Fever Hospital 171 cases of scarlet-fever; making a total of 2,195 cases. Of these 262, or less than twelve per cent,

died. A special difficulty in the way of the hospital treatment of scarlet-fever is the great youthfulness of most of the sufferers. On this account, it is sometimes neither easy nor wise to separate them from their parents. Nevertheless it seems probable that a plan could be devised, which would surmount this trouble, and perhaps convert it into a help instead of a hinderance. The management of hospitals for infectious diseases is often made troublesome from the fact of the great irregularity in the prevalence of such diseases. Hence it is difficult to have at call a sufficient number of nurses to provide the many cases which present themselves during an epidemic, without employing more attendants than would be needed through many months when scarlet-fever might but rarely occur. If the arrangement of the hospital made provision for the use of mothers as nurses to their own children, it might prove not only a more agreeable but also more economical plan.

Having regard to the fact that very often for long periods the building would not be required at all, it would be more economical, and in every way more satisfactory, to hire nurses at the time when they might be required, and to pay a medical attendant for services rendered, than to attempt to procure one or the other by a fixed salary. A plan like this, which may be modified to suit various requirements, would meet well the needs of the cities and towns of our own State, for it is capable of extension without material alteration. With judicious adjustment of details in its management, mothers might frequently be found the most available as well as the most contented and faithful nurses.

Besides hospitals, to which scarlet-fever patients can be at once carried and so isolated, some house or houses are needed, where members of a family in which an infectious disease has occurred can remain until their infected apartments can be disinfected. Such houses need involve but trifling expense. The temporary occupants should be made to keep their premises clean, and to do their own cooking and housework. A small amount of additional police direction and labor should keep such homes neat and comfortable.

From a report by Sanitary Inspector Kenneth M. Macleod of Glasgow, on the operations of the Sanitary Department of that city, for the four years ending April 30, 1877, we

learn that in Glasgow there is a reception-house specially set apart for all such families as require to be removed from fever-infected dwellings, while these are undergoing purification. It is sometimes used to such an extent that the question of its enlargement requires consideration. The following table shows the number they lodged during each of the last four years: —

YEAR.	Number of Families Accommodated.	Number and Sex of Individuals.		Total.
		Male.	Female.	
1873-74, ...	67	96	98	194
1874-75, ...	118	168	189	357
1875-76, ...	101	158	121	279
1876-77, ...	91	113	126	239
Total, ...	377	535	534	1,069

Reception-houses, like those in use in Glasgow, might furnish homes for those who have been exposed to contagion; not only until their rooms can be freed from infection, but until a necessary time of quarantine has passed.

Hospitals, etc., Needed.

In very many of our large cities and towns, some public provision[1] has been made for the isolation of patients with small-pox; while for scarlet-fever, an equally contagious and more widely fatal disorder, few public accommodations exist. Yet such provision is more urgently needed to arrest the extension of this latter disease, inasmuch as we have no protection against scarlet-fever, such as vaccination affords against small-pox. Probably some plan could be devised by which the present provisions against small-pox could be combined with hospital accommodations for patients with scarlet-fever.

It is clear, also, that with hospitals and "reception-houses," we must have authority conferred upon and exercised by responsible persons, who shall kindly insist upon the use of these public accommodations by all persons whose surroundings make it necessary that they should be taken from their own rooms. It is evident, that thus far wards for this infec-

[1] Too often, it is true, of a very rude and inhospitable nature.

tious disease are regarded not so much as one of the most important means to stop the spread of contagion, as they are esteemed as devices by which an infectious disease can be safely treated within hospital limits. But of the need of public authoritative control of this disease, we shall have occasion to speak farther on.

Disinfecting-Apparatus Needed.

Difficulties in the way of securing the efficient use of disinfectants arise from the general lack of suitable disinfecting-apparatus, from ignorance of the chemical properties and incompatibilities of the powerful agents used for this purpose, and from inexperience, carelessness, or negligence in their application. It will perhaps have been noticed that, while heat has been mentioned as the best of disinfectants, no directions have been given for its use, excepting the rule to boil all cloths and clothing before they are to be washed. This is for the reason that a safe and effective use of high temperatures requires arrangements which are quite cumbersome and expensive. With the prospect of only a contingent, or, at best, a very infrequent use of such apparatus, we cannot expect its addition to private houses. Yet for many articles there is no agent which can be so effectually applied. Heavy woollen goods, furs, and bedding are with great difficulty disinfected by other agents. Even after fumigation and airing, we cannot so confidently consider them free from infection, as we may after they have been subjected to a heat of 212° Fahrenheit.

For using high temperatures, various forms of disinfecting-apparatus have been devised. One of the best of these is in use at Liverpool. To obtain information concerning this apparatus, the Secretary of the State Board of Health wrote to Dr. J. Stopford Taylor, Deputy Medical Officer of Health for the Borough of Liverpool. In generous response, excellent colored plans were sent to Dr. Folsom, accompanied with explanatory text, and the following kind letter containing much valuable information: —

MUNICIPAL OFFICES, DALE STREET,
MEDICAL OFFICER OF HEALTH'S DEPARTMENT,
LIVERPOOL, Sept. 17, 1877.

MY DEAR SIR, — I have much pleasure in complying with the request contained in your favor of the 29th ult., and am having

prepared a tracing and description of our disinfecting-stoves, which shall be forwarded as soon as completed.

We have two stoves for disinfecting the clothing and bedding of patients suffering from fever, small-pox, scarlatina, and diphtheria; which are brought from the patients' homes in one van, and sent back after disinfection in another. The rooms are also disinfected with sulphur, and then thoroughly cleansed.

All persons are obliged on my order to have the clothing and rooms disinfected; and in my report you will find the number of articles disinfected the past year.

You are no doubt aware that we have just passed through an epidemic of small-pox. Two of our large industrial schools, and the children's infirmary, were invaded by the disease, and many cases occurred in them. The patients were removed to the hospital, the clothing and rooms disinfected and cleansed, and the disease was thus stamped out in a very short time.

With scarlatina there is a difficulty, as most of the cases are in young children, who require a mother's care; yet where there is not proper accommodation, nor sufficient means for isolation in their homes, we have them removed to the hospital, but nothing like the same proportion of cases as of other infectious diseases.

We also report to the School Board, and head masters of the various schools, the names of children, who, living at infected homes, are in attendance at the schools, and likely to be a means of spreading the disease. The children are then sent home, and not allowed to return until a fortnight after their homes have been disinfected.

Yours faithfully,

J. STOPFORD TAYLOR.

C. F. FOLSOM, ESQ.
Sec'y to State Board of Health, Boston.

Description[1] *of Disinfecting-Establishment in Liverpool.*

The most approved apparatus in Liverpool is that shown on sheets A, B, and C., with the disinfecting-stoves modified as shown in detail at D.

The plot of land on which the buildings are erected is situate in New Bird Street, with a frontage thereto of fifty-six feet, and extending backwards to the depth of above seventy feet. They comprise a spacious flagged courtyard with paved cartway, a residence for the keeper, a well-ventilated receiving-room for infected clothes, a depository for disinfected clothes, a wash-house for

[1] Kindly furnished us by George F. Deacon, Esq., C.E., Borough Engineer of Liverpool.

cleansing infected clothing, containing eight washing-troughs supplied by steam from the boiler in the basement, a drying-closet opening directly into the wash-house, and a range of disinfecting-chambers under the open shed in the courtyard.

In the basement are the boiler, stoking-pit, heating apparatus, and the coal and ash vaults.

The disinfecting-stoves are each five feet wide, seven feet from front to back, and six feet six inches high to the springing of the arch.

In the apparatus shown on plans A, B, and C, the clothes-horses are fixed wooden bearers; in the improved apparatus shown on plan D, they are light rolling frames.

The walls and vault are built of brickwork; the doors are of wrought-iron, fitting tightly into cast-iron frames.

The floors are formed with double iron gratings, having alternate openings; the under one being constructed so as to slide to exclude, if desired, the hot air.

In the arch over the centre of each stove is an opening containing an iron valve for the escape of foul air into an exhaust-flue, which is carried over the top of the stoves into the chimney-shaft, in plans A, B, and C, and into the ash-pit under the heating-cockle in plan D. The latter arrangement seems unnecessary: it was, however, adopted to remove the fears of certain persons in the neighborhood, who believed that the fumes issuing from the chimney would be infected.

The drying-closet in the wash-house is similar to the disinfecting-stove, with the exception that the sliding bearers are much lighter.

With the heating apparatus, which is a cast-iron cockle, two cast-iron smoke-tight flues are connected, which, after forming a coil, are conveyed along the hot-air chamber under the stoves into the chimney at the opposite end.

The furnace-doors and ash-hole are each regulated by means of sliding dampers.

Cold air is drawn from the atmosphere, through a descending shaft, thence along a brick flue underneath the floors of the stoke-hole into a cavity on each side of the cockle, after passing which it is highly heated, and conveyed into a chamber extending underneath the whole length of the stoves and drying-closet, from which it is admitted into the stoves through the sliding gratings before mentioned.

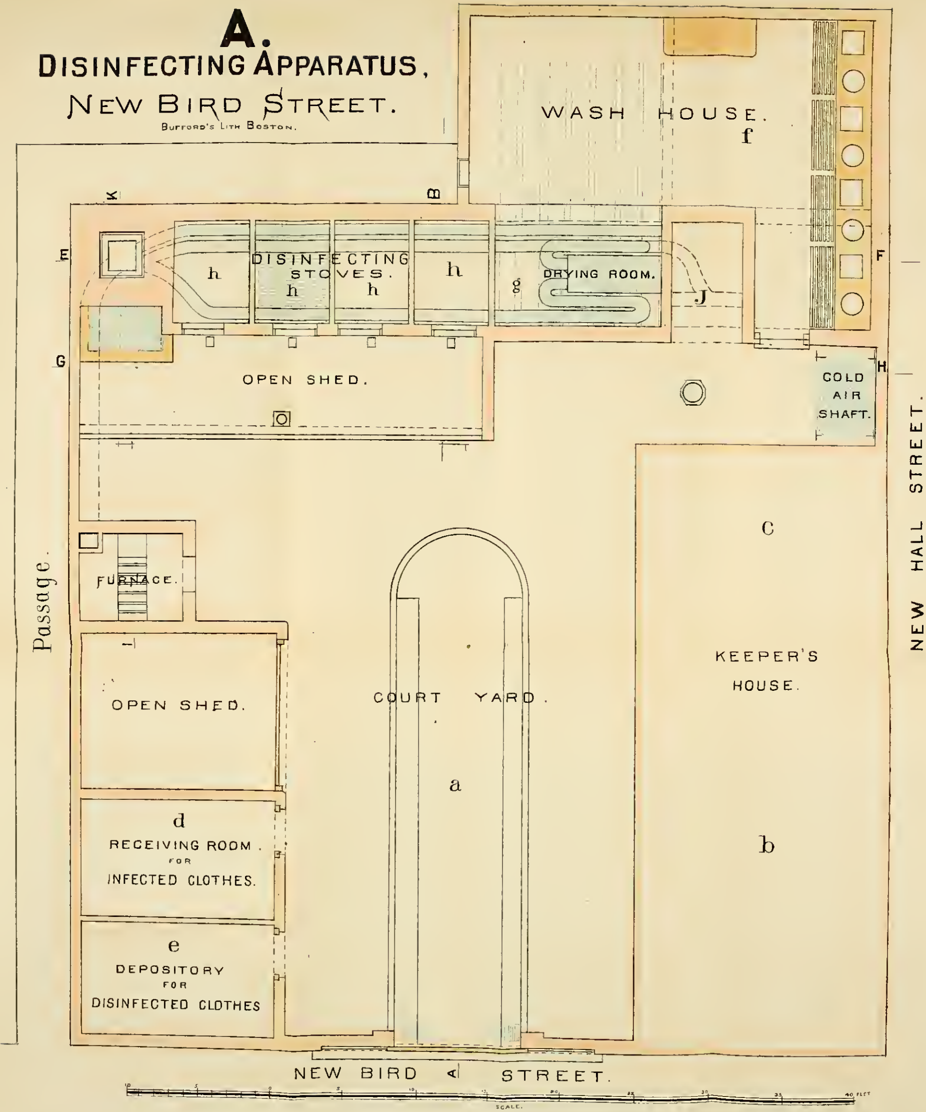
The temperature of the air is regulated by means of a damper at the entrance to the cold-air flue. As many as 380 degrees Fah. have been registered in the drying-closet over the cockle, and 280 degrees in the stoves.

A.

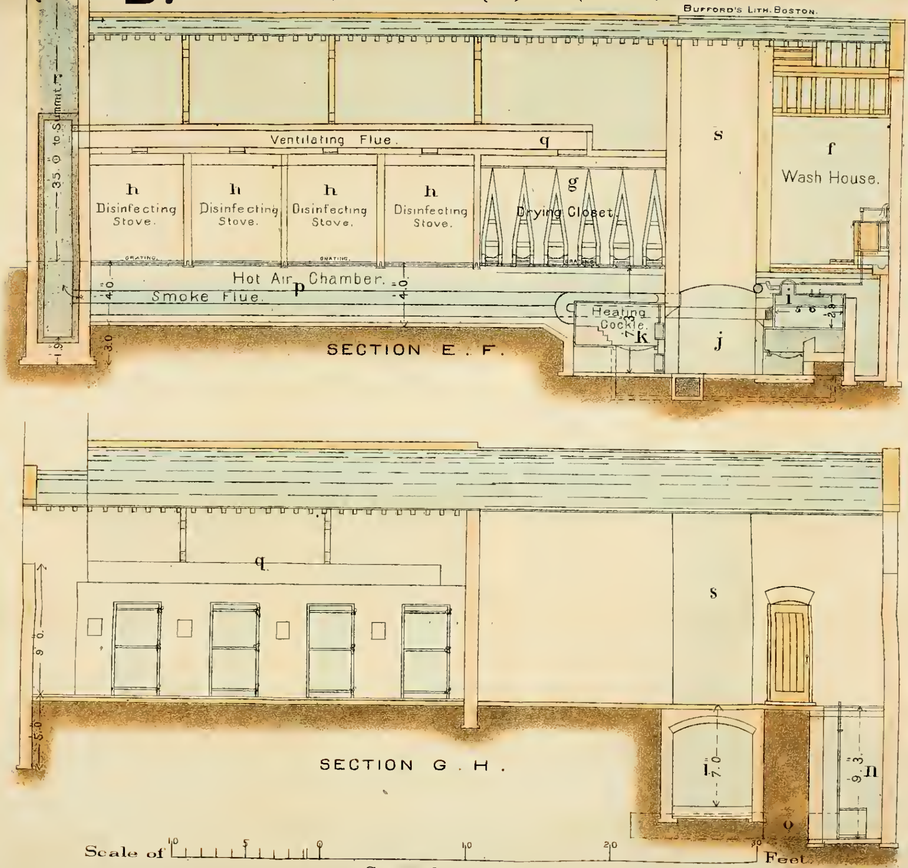
DISINFECTING APPARATUS,

NEW BIRD STREET.

BUFFORD'S LITH BOSTON.



B. DISINFECTING STATION, NEW BIRD STREET.

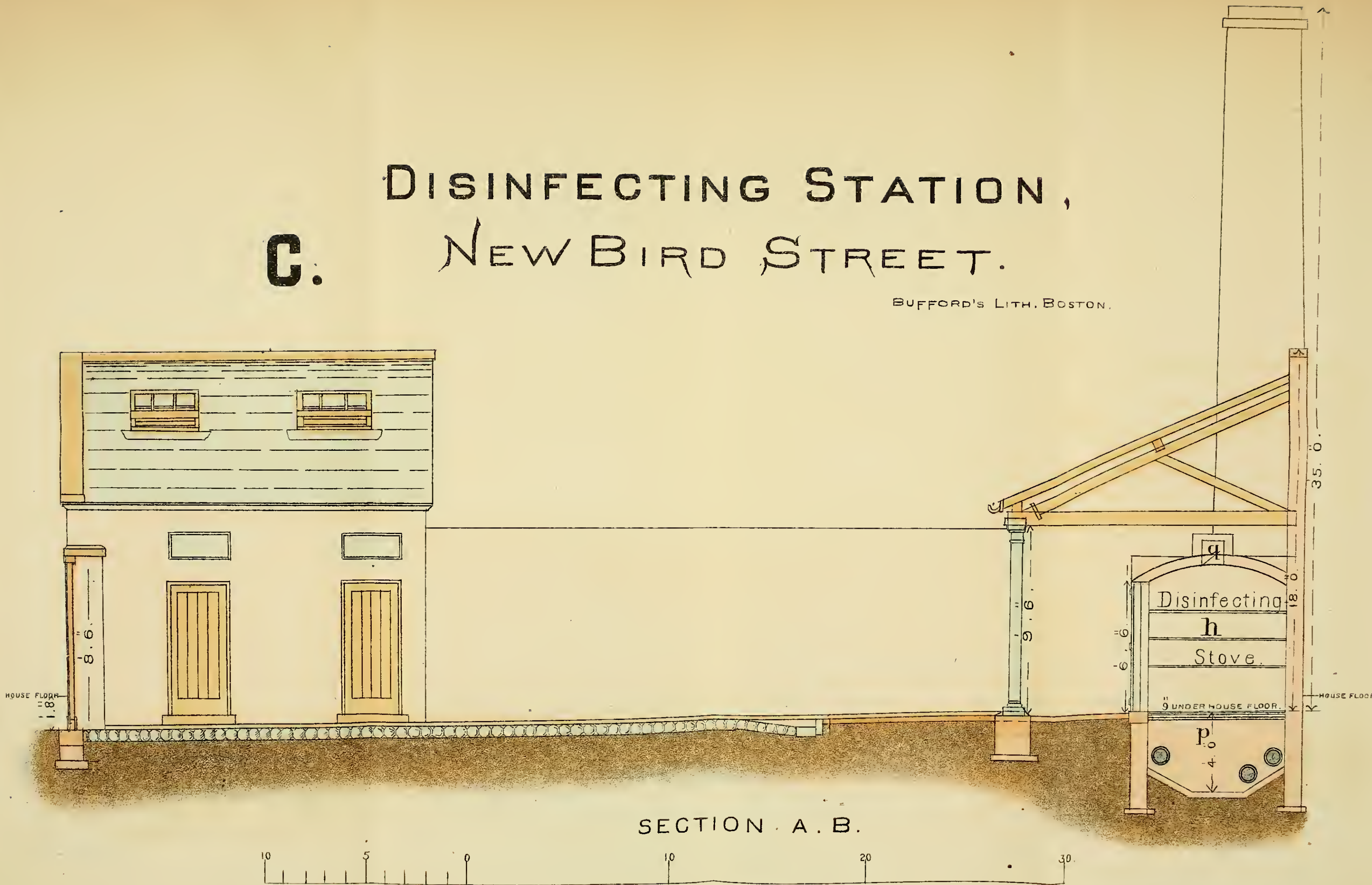


September 15th 1877.

C.

DISINFECTING STATION,
NEW BIRD STREET.

BUFFORD'S LITH. BOSTON.



SECTION . A . B.

Scale of Feet.

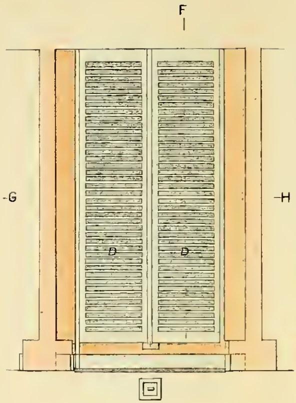
September 15th 1877.

DISINFECTING APPARATUS.

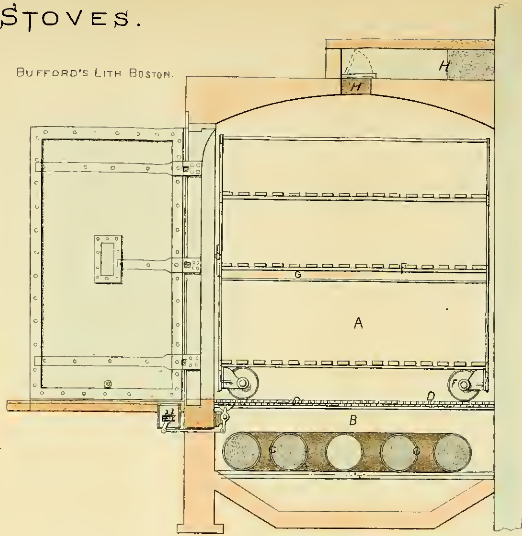
DETAILS OF STOVES.

D.

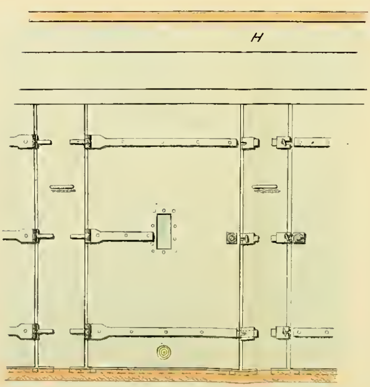
BUFFORD'S LITH BOSTON.



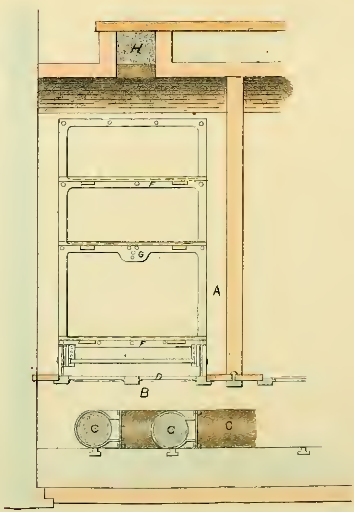
PLAN.



SECTION ON LINE E.F.



ELEVATION.



SECTION ON LINE G.H.

Scale of Feet.

September 22d 1877.

Reference to the Drawings A, B, and C.

A, Courtyard.
B, Keeper's cottage.
C, Yard to keeper's cottage.
D, Receiving-house for infected clothes.
E, Depository for clothes after they are disinfected.
F, Wash-house.
G. Drying-closet.
H, Disinfecting-stoves.
I, Boiler.
J, Stoke-hole.
K, Heating-apparatus.
L, Coals.
M, Ashes.
N, Cold-air shaft.
O, Cold-air flue.
P. Hot-air chamber.
Q, Exhaust-flue.
R, Chimney-shaft.
S, Cistern.

Reference to Detail Drawings D, showing the last-constructed stove.

A, Stove.
B, Hot-air chamber.
C, Smoke-flues for cockle.
D, Fixed and sliding gratings forming floor of stove.
E, Lever for opening and shutting grating.
F, Wrought-iron clothes-horse.
G, Thermometer tube to centre of each clothes-horse.
H, Exhaust-flue.

In his "Report of the Health of Liverpool" during the year 1876, Dr. Taylor publishes the statement that during the year "the number of articles sent to the disinfecting-apparatus amounted to 55,718."

During the year 1875, disinfecting-chambers were annexed to the Municipal Hospital in Philadelphia. The annex is a building "constructed of stone, pointed, and is one story high with a basement. It contains on one floor, a bath-room supplied with hot and cold water, six by eight feet, communicating with a dressing-room eight by ten feet; a fumigating-chamber six by eleven feet; and a hot-air chamber eight by eleven feet. The fumigating-chamber is made perfectly tight, so as to completely confine the gases liberated for the purposes of disinfection. The articles to be purified are suspended, and exposed to the fumes of burning sulphur, or other gases, for hours; the length of time being regulated by the character of the substances submitted to the process." The hot-air chamber is a modification of those in use in Liverpool. Concerning this annex the Report [1] says: "The introduction of the disinfecting-apparatus supplies a want that has long been a source of embarrassment. Not only is such an establishment needed for the proper treatment of the clothing of patients, and articles in use at the hospital which cannot be thoroughly disinfected by the ordinary process of washing; but is also of great service in the management of clothing, beds, bedding, &c., sent to the hospital for the express purpose of disinfection. Heretofore it has been necessary to burn many articles which might otherwise have been preserved and returned. . . . As a public health measure, it is important that greater facilities for disinfecting articles of clothing, &c., be provided for citizens; and, for this object, one or more disinfecting-chambers should be established in other parts of the city. The charges could be regulated so as simply to cover the expense; or the work might be done gratuitously, for the same reason that vaccination is afforded to people free of charge."

If it is necessary to forbid all persons to send infected clothes, carpets, or other goods to public laundries for cleansing (and of this there can be no doubt), then some public provision should be made to relieve those who may thus be

[1] Report of the Board of Health of the City and Port of Philadelphia, for the year 1875.

severely burdened for the public good. The construction of disinfecting-chambers would not only afford great relief to families whose household goods required purification, but would more completely insure the public safety by the thorough destruction of contagion.

Skilled Inspectors Needed.

From our review of the various chemicals generally used as disinfectants, it is evident that they are agents of such deadly power that their use should not be trusted to ignorant or careless persons. Moreover, to so apply them that they may thoroughly destroy infection, requires a knowledge of many details of procedure which many lack; or, having the necessary knowledge, they may lack practised tact, without which their efforts will be ineffectual. For these reasons if for no others, it seems wise to intrust the matter of disinfection of premises and their fixtures to persons who are trained for such work. These persons should be public officials, who should not only perform the work necessary for disinfection in houses whose inmates are incapable of doing such work themselves, but they should be required to exercise supervision over each and every case where disinfection is required and attempted. Very little satisfaction is likely to result from a partial and heedless use of disinfectants. Under such use much contagious matter is likely to remain undestroyed. Consequently the disease will break out afresh in places where it was delusively supposed to be quenched. Such an event will be supposed to illustrate the futility of attempts to destroy infection by solutions and fumigations: hence many persons will become more than ever indifferent concerning the use of means to prevent the spread of contagion. In some cities the disinfection of houses in which a contagious disease has occurred is supervised and performed by the members of a corps especially qualified for and appointed to this work.

A Disinfecting Corps is connected with the Health Department of the City of New York, under the general direction of the Sanitary Superintendent." Among many other duties, they attend to "the removal of persons sick with contagious diseases to hospital, and the disinfection or fumigation of rooms and dwellings infected, or that have been exposed to infection."

Popular Education.

We can hardly hope that efforts to protect a community against the ravages of scarlet-fever, or other infectious diseases, will be commendably successful, until some public action is taken to instruct people concerning *the initial symptoms*, as well as the contagiousness, of these forms of sickness, and concerning the measures which should at once be adopted for the protection of their own and others' children.

Local Boards of Health.

Notwithstanding the very great value of instructions, concerning the characteristics and dangerous nature of this disease, which may be printed and distributed under the authority of a State Board of Health, it is evident that they can *but partially* give to the general public the education which will lead people to act promptly to control the spread of scarlet-fever. Local boards of health have a more intimate knowledge of the special characteristics of their own communities. They are best fitted to select and use the methods by which published information concerning infectious diseases shall be forced upon the attention of all classes. The value of information distributed by a State Board of Health will depend upon the fidelity with which local boards of health give it wide circulation, and secure the execution of measures the information may indicate as necessary.

Both our local and State laws, with reference to the conduct which must be observed to restrict the spread of infectious disease, should be guarded by sufficient penalties to appeal to the selfish interests of would-be offenders. With the affixing of penalties for the non-observance of sanitary rules, there will arise many attempts at concealment of the existence or of the nature of this disease. This difficulty is only to be overcome by the special watchfulness of local boards of health. The attending physician may be required, under penalty for failure to do so, to report each case of scarlet-fever to a public health officer, who shall then see that the family are fully informed as to the rules they must practise, and who shall insure sufficient isolation and disinfection.

The value of this method of procedure is well illustrated by a recent experience in an English town. Dr. Thorne

Thorne,[1] a local government inspector, in a report to the Local Government Board, relates the circumstances connected with an extensive epidemic of scarlet-fever in Great Massingham, in which the persistent presence and diffusion of the disease was due to a failure to apply necessary restrictive measures. He then contrasts with this occurrence the results of faithful efforts to check the spread of scarlet-fever in King's Lynn, as follows: —

"Since mention has been made in another part of this report, of a prevalence of scarlet-fever in King's Lynn, it may be well by way of contrast to refer to the sanitary administration of that borough with regard to infectious disease. From information supplied to me it appears that the urban Sanitary Authority have arranged to pay a fee to the poor-law medical officers practising within their district each time that they report the existence of a case of infectious disease to their medical officer of health; and that information thus acquired is invariably supplemented, as indeed was the case formerly in the Freebridge Lynn District, by reports of a similar character, which are voluntarily forwarded to the same officer by private medical practitioners. By such means the officers of the Authority were informed of all the cases of scarlet-fever which appeared in King's Lynn during the period of the recent epidemics in the Freebridge Lynn Union. The houses affected were at once visited by the medical officer of health, and if necessary the inspector of nuisances also; printed instructions, which are always kept in readiness, were delivered to the householders, describing the measures which should be adopted to prevent the spread of the disease, and, in case of a death, the precautions which should be taken in connection with the burial of the dead. These instructions were always supplemented by verbal explanations on the part of the medical officer of health, who also exercised a personal supervision in regard to the measures adopted for the disinfection or destruction of infected articles, &c. The result of this, even in the absence of the provision by the urban Sanitary Authority of means of isolation for infectious diseases, has up to the present date been highly satisfactory: no spread of the disease has in any instance occurred beyond the house first affected, and nearly every case has been a single one. It is, indeed, impossible not to connect the course taken with the notable restriction of the disease in King's Lynn, as compared with its wide-spread prevalence in the Freebridge Lynn rural sanitary district, where no similar course was taken."

[1] London Times, Aug. 11, 1877.

If, however, the disease should assume a very mild form, no physician may be summoned. The parents or householder may then be required to inform the health officer. Or even in severer attacks, a family may seek, by doing without a physician, to escape the attentions of the health officer. Sometimes the police patrol can gain and report information of these cases of concealed sickness; and sometimes, when a neighborhood is duly informed concerning the nature of this disease, it can be discovered by offering a bounty to any person who, in the absence of any attending physician, will give the first information concerning its location. If pains are taken to distribute through public officers, to the uneducated and poorer classes, a proper knowledge of the contagiousness of scarlet-fever, their own fears might be their best protection.

All Classes and Persons interested in restricting Infection.

With many people whose lives are comfortably provided for, there is an apparent indifference to disease which seems at a distance from their own doors. To such the existence of scarlet-fever in tenement-houses, or in the somewhat distant homes of the poor, gives but little anxiety concerning the safety of their own families. Humanity would forbid indifference to the exposure of even the lower classes of society to pestilence. But added to this consideration is the fact that the selfish personal interest of all grades of society is involved in the suppression of infectious disease in any and every quarter in which it may show itself. It will not do to forget the indirect intercourse which exists between the houses in the better and in the poorer sections of a city or town, nor that there are innumerable ways in which infection tolerated as a remote evil in the dwellings of the negligent and lazy may be brought into the presence or scattered in the path of the cautious, industrious, and more valuable members of society.

Contact with infection may occur on the streets, in public buildings, or public conveyances, or by means of articles which are brought from or by infected persons to healthy homes. If no searching sanitary inspection and control of houses occupied by ignorant and reckless persons is exercised, the infection producing fatal sickness when least suspected

may be brought into the midst of any homes, however apparently well protected against disease.

Much evidence has been presented by several observers to show that milk forms a favorable medium for the transmission of the "germs" of different diseases, such as typhoid and scarlet fever. That it has been the vehicle by means of which the latter disease has been conveyed to many persons, seems indicated by the following evidence.

Dr. Buchanan reports the circumstances connected with an outbreak of scarlet-fever in connection with a dinner party at South Kensington,[1] which are so peculiar as to leave but little doubt that the milk from a certain dairy was the source of the infection.

Dr. Thomas[2] tells us that "Dr. Taylor observed that one of the first severe cases which initiated an epidemic occurred in the house of a milkman, whose wife milked the cows, the milk being supplied to about twelve families in the city. In six of these, cases of scarlatina occurred in rapid succession at a time when the disease was not epidemic, and without any communication having taken place between those that became affected and the person who had brought the milk. It is very probable that in this instance the milk was the carrier of the contagion, as previous to its distribution to the several consumers it had stood in a kitchen, which before had been used as a hospital for scarlatinous patients."

Summary.

The character of the methods we have enumerated is such as to suggest that there are innumerable similar ways in which the infection of even distant disease may be sown broadcast through the most carefully protected homes. The cleansing of infected carpets or clothing at laundries, the sale of infected carpets or furniture or other articles at auction, or the sale of infected cloths or rags to the peddler who may carry his bag from house to house, are some of the more obvious means of spreading contagion, which can only be made inactive by stringent laws to control intercourse with the sick, and to arrest the distribution of infected articles until the virulent power is destroyed. But there is no place

[1] Report of the Medical Officer of the Privy Council to the Local Government Board for the year 1875; p. 72.

[2] Ziemssen's Cyclopædia, vol. ii.

at which families of all classes and all quarters of a city come more frequently in contact than in our public schools. Thus an open way for the communication of infection is created.

We have already presented evidence showing that children in whom the disease was not recognized, or whose parents were unscrupulous as well as ignorant, have attended school while in a condition to freely distribute contagion. There are two methods by which this source of danger may be removed. One is the exclusion from schools of infected children, or of those justly under suspicion of being infected. The other is the public control and disinfection of all households in which infectious disease occurs. The first method should only be adopted as an auxiliary to the second: it is quite insufficient by itself. If scarlet-fever exists among ignorant and negligent families, and children from such families are simply excluded for a few weeks from school, when it is known that they have, or are likely to have, an infectious disease, many opportunities for conveying contagion to school-children will still exist. An infected child may present himself at school, and receive his first directions to remain at home in the presence of other children. Again, after the usual time of exclusion has been observed, if no public attention is given to the duty of disinfection of the premises from which a child comes, infected clothing may be worn, or articles brought to school, at any time for many months. Moreover, the same children that are excluded from the schoolroom may be found mingling with their school acquaintances out of school hours. To close against contagion the way which is opened by the association and acquaintanceship of children in public schools, a community should, through competent officials, seek out, control, and destroy contagion at the house in which it originated. If, as has been proposed, a medical inspector of schools should be appointed by any city or town, doubtful cases might be submitted to his examination and opinion.

That there is great need of more careful attention to our local school laws, with reference to infectious diseases, is shown by replies which have been received from physicians, superintendents of schools, and chairmen of school committees, in various parts of our State. From these replies it

appears that in many towns no laws have been framed, nor any measures taken by school authorities, to prevent the spread of infection among pupils in public schools. In other towns the action of the public authority takes the form of a *request* to parents, that when scarlet-fever exists in their families they will withhold their children from school. In other places the time of exclusion of infected children is too short, or the time is left to the discretion of the family physician, whoever he may be. In some places the ordinances are quite indefinite, or ambiguous, or expressed in terms which make strict compliance with them impossible. In many places, the regulations give evidence that they have been framed with little regard to the necessary medical information; while the school authorities of a few cities have evidently sought by carefully-considered legal requirements to protect the children under their care. There are more helps to the restriction of disease, at present, offered by laws on our statute-book, than are used. In every community there is a tendency to consider evils suppressed so soon as a law against them is enacted.

Together with laws we need local health authorities, who will take an intelligent and zealous interest in sanitary measures, and carry into effect the laws which are framed, with the full knowledge that they are necessary for the saving of human life. Every community, however small, should by laws and through active and competent officials to execute them, protect itself against the sources of disease. In so doing each community acts not only for itself, but, in these days of rapid transit and free communication, it works for the protection of all parts of the State. Sanitary laws should not be so often considered the peculiar requirements of large cities and towns. It is clear, that if the larger communities are to enjoy protection from infectious disease, by diligent attention to the rules for its suppression, this result can only be achieved when all outlying cities and towns are also held under strict sanitary rule and watch. The wider, more general and thorough, the co-operation of local boards of health with the State Board of Health, the more evident and remunerative will be the results of efforts to suppress a disease like scarlet-fever.

REPORT

ON THE

SANITARY CONDITION

OF

CAMBRIDGE.

BY

EDWARD R. COGSWELL, M.D.,

MEDICAL CORRESPONDENT OF THE BOARD FOR THE CITY OF CAMBRIDGE.

THE SANITARY CONDITION OF CAMBRIDGE.

I. — Natural Conditions affecting Health.

Situation. — Cambridge is situated in latitude 42° 22′ 48.6″ north, and in longitude 71° 7′ 45.15″ west from Greenwich.[1]

Topography. — The Charles River forms its southern and eastern boundary, with a shore line of over six miles; on the north-east it is bounded, for a distance of half a mile, by an arm of the sea called Miller's River, the upper basins of which are filled in with gravel.

It is estimated that one-third of the territory of Cambridge consists of marsh, from which the upland rises so gradually that a considerable portion of the latter is but a few feet above high-water mark. The highest point of land is found in the northern part of the city, at an elevation of seventy-seven feet above mean high water. South-westerly of this hill, and forming a part of the same range, is the eminence on which the Observatory stands; and beyond, in the same direction, is Reservoir Hill. One mile and a quarter south-east from the Observatory is the summit of Dana Hill; and there is one other elevation of land of sufficient height to be called a hill, the top of which is near the corner of Otis and Fourth Streets. The height of several points above mean high water is shown on the map by small red figures. The western boundary of the city is formed by Fresh Pond and its former outlet, Alewife Brook, which empties into Mystic River, after flowing through extensive meadows, portions of which are within the limits of Cambridge. With the exception of two or three very small and short streams, there are now no open water-courses within the city limits. Others which formerly existed have disappeared since the building of sewers.

Geological Structure.[2] — The geological structure of Cam-

[1] Latitude and longitude of Cambridge Observatory.

[2] For the account of the geological structure of Cambridge, the writer is indebted to Professor N. S. Shaler of Harvard University.

bridge is very simple, yet it has a great effect upon the nature of the soil and the character of the drainage. At no point in Cambridge, except perhaps over a few acres near the almshouse on the Somerville line, do the older rocks of the country come nearer to the surface than about ten feet below its level. Generally they lie over forty feet below it. All the rocks of Cambridge, which in any way affect the soil or the natural and artificial drainage, belong to the class of deposits commonly known as glacial drift, or have been recently recomposed by the working-over of these deposits. These glacial and post-glacial deposits are naturally divided into three groups: viz.,—

First, The old unstratified drift, or bowlder clay; a dense impervious mass of sand, pebbles, and bowlders, cemented by clay, and compacted by the weight of the old ice-sheet. It contains some water near its upper part, but is too dense to hold much: its surface is covered by strong clay soils. It forms the tops of the ranges of hills for a depth of twenty feet from the surface.

Second, Stratified sands and gravels made by the washing about of the bowlder-clay materials, and characterized by an open structure, through which the water penetrates with great ease; the ground-water level being somewhat variable, but in all cases lying ten feet or more below the surface. These deposits form terraces, or broad tables, slightly rolling, from fifteen to forty-five feet above high tide.

Third, Salt-water or brick clays, which deposits, newer than the two preceding, occupy lower levels. They are dense stratified clays, with few pebbles, and are even more impervious to water than the bowlder clays, from the waste of which they are derived. They are generally found at levels below twenty feet above high-water mark.

Fourth, Peaty marshes. These deposits have all been formed since the end of the series of events which were intimately connected with the glacial period, and since the re-elevation of the shore to its present level. All the deposits heretofore described are entirely free from all trace of vegetable matter: these peat-swamps are principally composed of that substance. They are of mingled salt and fresh water origin, and generally constitute a coating on top of the clays, being rarely found over the gravels. These several deposits

are combined in a most complicated manner, small patches of brick-clay to the number of twenty or thirty being scattered through the city; and there are at least that number of peat-bogs, large and small. These last are often masked by a thin sheet of sand and gravel, washed in from higher ground.[1]

Temperature, Rainfall, &c. — From the observations recorded at the Harvard College Observatory, we find the mean annual temperature during the years 1861–1876 to have been 47.2° Fah. In 1870 the mean temperature was 49.5°, and in 1875, 44.9°, a difference of 4.6°. The average temperature of the spring months is 43.8°; of the summer, 69.5°; of the autumn, 49.8°; of the winter, 25.7°.

During the years above mentioned, the mean temperature of each month was as follows: viz., —

January, ...	24.3°	October, ...	50.2°
February, ...	25.7°	May, ...	55.8°
December, ...	27.2°	September, ...	61.0°
March, ...	31.9°	June, ...	66.6°
November, ...	38.2°	August, ...	69.7°
April, ...	43.8°	July, ...	72.2°

The difference between the warmest and coldest months is 47.9°.

During the five years 1872–1876, the maximum temperature observed was 94.5° Fah., July 31, 1876, and the minimum —13.6° Fah., Jan. 30, 1873.

The average annual rainfall is greater than in Eastern Massachusetts generally: for the sixteen years before mentioned, it was 45.46 inches.

The maximum annual rainfall was 57.19 inches in 1862, and the minimum was 31.92 inches in 1866.

The prevailing winds are westerly; but, from the situation of the city, the peculiar effects of the easterly wind are strongly felt.

II. — The Population.

The population of Cambridge, as given by the state and national census reports since 1859, is shown on the next page.

[1] For a more detailed account of the geological structure of the different parts of Cambridge, see page 364, and following pages.

1860,	26,060	1870,	39,634
1865,	29,112	1875,	47,838

Rate of Increase. — From 1860 to 1865, the average annual rate of increase was 2.25 per cent; from 1865 to 1870, 6.35 per cent; and from 1870 to 1875, 3.83 per cent. In this paper the population for the years when no general census was taken is calculated from these percentages: except that in 1876 and 1877 the gain over the year 1875 is estimated at 1.1 per cent; this being the rate of increase in the number of persons between the ages of five and fifteen years, as shown by the special census taken under the direction of the school committee.

About eight hundred of the students of Harvard College and the professional schools connected with it are included in the population of Cambridge, and form an important element thereof from a sanitary point of view. The addition to the population of this large number of young and vigorous adults, among whom fatal disease is very rare, tends to lower the death-rate of the city as a whole, and makes its sanitary condition, as judged by that standard, appear somewhat better than it really is.

Nationality. — According to the census of 1875, 31.4 per cent of the total population were foreign-born.

The table below shows the proportion of the various foreign nationalities to the total population and to each other.

BIRTHPLACE.	Number.	Percentage of total population.	Percentage of foreign-born.
Ireland,	8,551	17.8	56.8
Dominion of Canada,	2,974	6.2	19.0
England,	1,470	3.0	9.8
Germany,	641	1.3	4.2
Scotland,	493	1.0	3.2
Sweden and Norway,	193	.4	1.2
Other foreign countries,	710	1.7	5.8

The black and mulatto population numbered 1,103, more than are to be found in any city of the State except Boston and New Bedford.

Age Distribution.—In the next table will be found the age distribution of the population of Cambridge.

AGE.	Number.	Per cent of population.	AGE.	Number.	Per cent of population.
Under 5, . .	5,567	11.6	80 to 90, . .	178	.3
5 to 10, . .	4,809	10.0	90, . . .	14	.03
10 to 15, . .	4,129	8.6	Unknown, .	550	1.1
15 to 20, . .	4,670	9.7	Under 15, .	14,505	30.3
20 to 30, . .	9,846	20.5	15 to 60, . .	30,026	62.7
30 to 40, . .	7,301	15.2	Over 60, . .	2,757	5.7
40 to 50, . .	4,943	10.3			
50 to 60, . .	3,266	6.8	Under 20, .	19,175	40.0
60 to 70, . .	1,871	3.9	20 to 50, . .	22,090	46.1
70 to 80, . .	694	1.4	Over 50, . .	6,023	12.2

In comparison with the State at large, we find a larger proportion of persons under fifteen, especially of young children under five, and a smaller number of persons over sixty. The number between twenty and fifty years is nearly two per cent greater than in the State.

Occupation.— As in other suburban towns and cities, a great part of the inhabitants derive their support from occupations carried on in Boston. Cambridge differs from other large cities in the State in the fact that here we have no leading industry overshadowing all others, and possibly exerting an unfavorable influence upon the general sanitary condition of the community by its effect upon the health of those employed therein, or by concentrating large numbers of the population in a comparatively small area. The occupations giving employment to the largest number of persons are as follows: manufacture of musical instruments, chiefly organs, 583; furniture-manufacturing, 515; printing, 500; book-binding, 424.

Illiteracy.— Of the 37,462 persons above the age of ten years, 2,746 cannot read and write, a percentage of 7.3. Of these illiterates, 92 per cent are foreign born.

Pauperism.— Dec. 31, 1877, the total number of inmates of the almshouse was 96, exclusive of those confined for truancy or petty crime. Outdoor relief has been given during the last few years to a great extent; in 1876 the number so assisted was nearly six thousand: but this is not a

fair indication of the poverty actually existing in the city; for, when public aid is freely given, the number of applicants therefor will always be large.

Convicts. — At the time of taking the census of 1875, there were 302 convicts confined in the county institutions at East Cambridge. These are omitted in calculating the tables in the last part of this report.

III. — Artificial Conditions affecting Health.

Water-Supply. — Before the year 1856, the water-supply of Cambridge was derived entirely from wells, except in the eastern parts of Districts VII. and VIII. on the map accompanying this report, where spring water from Prospect Hill in Somerville was delivered by an aqueduct.

In December, 1856, a private company began to furnish water from Fresh Pond, and continued to do so until 1865, when the works were bought by the city. Since that time the works have been greatly enlarged and extended, until now they furnish almost the entire supply of the city. According to the census of 1875, there were in Cambridge 10,077 families: Dec. 1, 1877, 9,738 families were takers of water.

Fresh Pond lies partly within the city limits, and partly in the town of Belmont, and has an area of nearly two hundred acres. It has no streams running into it, being fed principally by springs. The natural outlet of the pond was through Alewife Brook to Mystic River; but of late years the level of the pond has been lower than the water in the brook, which is kept out of the pond by a gate, as it is now only an open ditch, receiving the drainage of about eight hundred acres of the territory of Cambridge through three large sewers. The greater part of the pond is bordered by gravel banks, which in places form steep hills rising directly from the margin of the pond. The land on its borders is mostly uncultivated, and there are but few dwellings in its immediate vicinity. On one of the hills is a grove which is a favorite resort for picnics, and is sometimes visited by as many as ten thousand people in one day. There is no direct drainage into the pond, either from the grove or from the hotel connected with it; but undoubtedly the pond receives a considerable amount of impurities from the presence on its banks of such large numbers of people.

On the Belmont side of the pond, near Cushing Street, is a settlement known as "Strawberry Hill," where most of the houses are of an inferior class. The drainage from a number of these houses and their outbuildings runs into the small pond which is shown on the map, and at times overflows into Fresh Pond. To prevent the future flow of sewage into the pond from this vicinity, it has been proposed to build a sewer from Cushing Street to the neighborhood of the water-works, there to connect with one of the sewers emptying into Alewife Brook. This would be the beginning of a marginal sewer to be carried, if necessary, at a future time entirely around the pond. Except from the two sources just mentioned, the prospect of the direct contamination of the water of Fresh Pond seems now to be slight.

On account of the rapidly increasing consumption of water, and the consequent lowering of the level of Fresh Pond, in 1875 the Legislature granted the right to take water from Spy Pond in Arlington, and Little Pond and Wellington Brook in Belmont. Under this authority two conduits have been built; one connecting Spy and Little Ponds, the other extending from Little Pond to Fresh Pond, and taking in the water of Wellington Brook on the way. So far, no use has been made of the water of Little and Spy Ponds; but the brook has been frequently turned into Fresh Pond, and a certain amount has been furnished by the filter-basin on the shore of Little Pond. The water in the filter-basin is believed to come mainly from springs, and not from the pond.

In the following table are given the results of various analyses of water from each of the above-mentioned sources of supply. They are presented here, that they may be preserved for future reference, and comparison with observations yet to be made.

Of these analyses, those marked H were made by Professor E. N. Horsford; those marked S were made for the Cambridge Water Board, by Stephen P. Sharples, S.B.; those marked N were made by Professor William Ripley Nichols, of the Massachusetts Institute of Technology.

Analyses of Cambridge Water Supply.

[Results expressed in parts per 100,000.]

Date.	Observer.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.			Chlorine.
					Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.	
October 1872,	S.	Fresh Pond,	–	–	16.49	5.00	21.49	–
1873,	H	Fresh Pond,	–	–	9.72	4.05	13.77	–
February 22, 1875,	S	Fresh Pond, Top,	0.0170	0.0155	8.00	5.00	13.00	1.99
22, 1875,	S	Fresh Pond, Bottom,	–	–	9.00	5.00	14.00	–
March 12, 1875,	S	Fresh Pond, Service,	–	–	9.00	4.00	13.00	–
June 2, 1875,	S	Fresh Pond, Service,	0.0010	0.0050	11.00	3.00	14.00	–
16, 1875,	S	Fresh Pond, Service,	0.0010	0.0050	9.50	3.00	12.50	–
March 13, 1876,	S	Fresh Pond, Service,	0.0048	0.0086	10.00	4.20	14.20	–
December 16, 1876,	S	Fresh Pond, Service,	0.0048	0.0060	9.00	3.50	12.50	–
13, 1876,	S	Fresh Pond, Top,	0.0160	0.0160	10.50	3.50	14.00	–
September 4, 1877,	N	Fresh Pond,	0.0061	0.0197	10.90	1.50	12.40	1.70
4, 1877,	N	Fresh Pond, Service,	0.0051	0.0248	–	–	–	1.20
October 1, 1877,	S	Fresh Pond,	0.0050	0.0148	10.00	3.50	13.50	–
1, 1877,	S	Fresh Pond, Service,	0.0016	0.0165	10.00	4.50	14.50	–
1, 1877,	S	Cambridge Reservoir,	0.0050	0.0198	9.70	5.30	15.00	–
18, 1877,	N	Fresh Pond, Top,	0.0144	0.0234	11.05	1.10	12.15	2.10
18, 1877,	N	Fresh Pond, Bottom,[1]	0.2592	0.0368	13.45	1.75	15.20	–
November 14, 1877,	N	Fresh Pond, Top,	0.0419	0.0179	11.90	2.40	14.30	1.81
14, 1877,	N	Fresh Pond, Bottom,	0.0429	0.0179	11.90	1.10	13.00	1.64
December 12, 1877,	N	Fresh Pond, Bottom,	0.0267	0.0243	–	–	–	1.89
12, 1877,	N	Fresh Pond, Bottom,	0.0264	0.0248	–	–	–	1.87
12, 1877,	N	Fresh Pond, Bottom,	0.0264	0.0212	–	–	–	1.82
12, 1877,	N	Fresh Pond, Bottom,	0.0264	0.0171	–	–	–	1.78
12, 1877,	N	Fresh Pond, Bottom,	0.0264	0.0177	–	–	–	1.84

12, 1877,	N	Fresh Pond, Bottom,	0.0269	0.0165	–	–	–	1.85
June 16, 1875,	S	Wellington Brook,	0.0020	0.0090	7.50	3.00	10.50	–
December 13, 1876,	S	Wellington Brook,[2]	0.0048	0.0064	7.50	3.50	11.00	–
13, 1876,	S	Wellington Brook,[3]	0.0048	0.0064	7.00	3.00	10.00	–
August 30, 1877,	N	Wellington Brook,	0.0125	0.0237	8.70	3.30	12.00	1.75
September 7, 1877,	N	Wellington Brook,	0.0088	0.0189	9.10	3.20	12.30	1.20
October 1, 1877,	S	Wellington Brook,	0.0050	0.0066	8.70	4.00	12.70	–
6, 1877,	N	Wellington Brook,	0.0280	0.0514	–	–	14.90	1.10
6, 1877,	N	Wellington Brook,[4]	0.0272	0.0680	12.60	3.90	16.50	1.00
6, 1877,	N	Wellington Brook,[5]	0.0243	0.0483	13.10	4.60	17.70	1.70
June –, 1875,	S	Little Pond, Top,	0.0016	0.0110	8.70	4.50	13.20	–
December 13, 1876,	S	Little Pond, Top,	0.0070	0.0120	8.00	6.00	14.00	–
August 30, 1877,	N	Little Pond,	0.0261	0.0624	–	–	–	3.10
September 7, 1877,	N	Little Pond,	0.1312	0.0981	13.30	5.80	19.10	2.60
October 1, 1877,	S	Little Pond,	0.0165	0.0165	14.20	4.50	18.70	–
August, 9, 1876,	S	Filter Basin,	0.0254	0.0231	12.00	6.00	18.00	2.21
December 13, 1876,	S	Filter Basin,	0.0080	0.0054	14.00	4.50	18.50	3.09
March 13, 1876,	S	Springs in Little Pond,	0.0064	0.0064	13.20	6.80	20.00	1.92
13, 1876,	S	Springs in Little Pond,	0.0128	0.0120	13.40	6.60	20.00	2.57
13, 1876,	S	Springs in Little Pond,	0.0088	0.0080	18.00	4.50	22.50	2.60
October 1, 1877,	S	Conduit from Little to Fresh Pond,	0.0040	0.0066	15.00	5.50	20.50	–
–, 1870,	H	Spy Pond, Outlet,	–	–	9.60	6.40	16.00	–
February 22, 1875,	S	Spy Pond, Top,	0.0124	0.0217	12.00	5.00	17.00	2.53
22, 1875,	S	Spy Pond, Bottom,	–	–	12.00	5.00	17.00	–
June 16, 1875,	S	Spy Pond, Top,	0.0060	0.0090	11.70	3.00	14.70	–
December 13, 1876,	S	Spy Pond, Top,	0.0192	0.0192	9.50	4.70	14.20	–
August 30, 1877,	N	Spy Pond,	0.0040	0.0539	10.60	2.80	13.40	3.40
October 1, 1877,	S	Spy Pond,	0.0033	0.0231	9.50	6.00	15.50	–

[1] This specimen of water was offensive to the taste and smell when taken from the pond: it probably came from the neighborhood of a mass of decaying matter. The result of six attempts to obtain another similar specimen on Dec. 12, 1877, is seen above.
[2] From above the pigsties.
[3] From below the pigsties.
[4] From a point opposite the pigsties.
[5] From the brook, at its entrance into the conduit.

If chemical analysis were all that is necessary to enable us to decide upon the safety of a water-supply, the results exhibited in the table above would be, so far as they go, reasonably satisfactory; but even then the final conclusion should not be based on a comparatively few scattered observations, such as we have given here, but upon analyses made at regular intervals, under varying circumstances, at all seasons of the year, after heavy rains, and in time of drought.

It is often assumed, that, if chemical analysis of water fails to show plainly the evidence of pollution, no further question of its desirability or safety can be raised. The best sanitary authorities, however, while acknowledging the importance of the assistance rendered by the chemist in the solution of these questions, agree that chemistry alone cannot settle the matter, and that other circumstances must also be taken into account.

Mr. John Simon, formerly Chief Medical Officer of the Privy Council of England, and a high authority, says of chemical tests: "Their negative findings are consequently not entitled to the same sort of confidence as their positive. Chemical demonstration of unstable nitrogenous compounds in water is a warning which, of course, should never be disregarded; but, till chemistry shall have learnt to identify the morbific elements themselves, its competence to declare them absent in any given case must evidently be judged incomplete, and waters which chemical analysis would probably not condemn may certainly be carrying in them very fatal seeds of infection."

The sources from which the direct contamination of Fresh Pond may possibly be apprehended have already been mentioned. It is believed by some, that, owing to the situation and surroundings of Spy and Little Ponds and Wellington Brook, their liability to dangerous contamination is so great as to make it unsafe to depend upon them as a means of future supply.

The entire water-shed of Fresh, Spy, and Little Ponds, and Wellington Brook, is estimated at five thousand acres, of which nearly one-half is drained by the brook. So far as is known to the writer, no observations have been made to determine the quantity of water in the brook, but it is at times very great. The bed of the stream is in most places only a

few feet in width; but after a heavy rain it rises rapidly, and overflows its banks, spreading widely over the adjacent lands, and then carries down a large amount of suspended matter. The brook gathers in a swamp near the village of Waverly, in the town of Belmont, and has a total length of about two miles and a half; its waters finding their way through the meadows into either Alewife Brook or Little River, the outlet of Spy and Little Ponds. Near its source it passes along the base of a steep and rocky hill, which forms the best portion of its water-shed; the rest of its course is partly through a comparatively level district, now thinly inhabited, but where the area of cultivated land devoted to market-gardening is constantly increasing. This land, like all similar tracts, is very highly manured, and its surface drainage passes into the brook.

Near the village of Belmont, the course of the stream is through a narrow valley, where it is liable to contamination by the direct drainage from the dwellings on its banks. Until recently, the privies connected with several houses in this neighborhood were placed directly over the brook, and it also received the drainage from these houses and from several barns and pigsties. The Water Board have caused the privies to be removed, and have constructed a dike with the intention of turning the drainage of the estate, where are kept the largest number of swine, from its former direct course into the brook, and forcing it to flow over the meadow before entering the stream. After a heavy rain, however, the water rises high enough to overflow this dike; and, for the time at least, this attempt to divert the drainage of the piggery is rendered abortive. With an increased population in the valley of the brook, the difficulty of preventing its contamination from sources similar to those just mentioned will become greater.

All authorities agree that the pollution of drinking-water by sewage is dangerous, not only on account of the effect which it may have upon the general health, but also by reason of the liability to the communication of specific disease: the only difference of opinion is upon the question of the possibility of purifying the water that has received it. The extreme opinion on one side is contained in the following passage from the Sixth Report of the English Com-

mission on the Pollution of Rivers: "There is no river in the United Kingdom long enough to secure the oxidation and destruction of any sewage which may be discharged into it, even at its source." On the other hand, it was claimed by the late Dr. Letheby, formerly medical officer of the City of London, as well as by others, that, if the sewage be diluted with twenty times its bulk of water, a flow of six or eight miles is sufficient to entirely destroy it.

If the latter view be correct, it can hardly be claimed that sufficient time will be given for the oxidation of sewage in a short stream like Wellington Brook, before its water enters Fresh Pond.

In the First Report of the Rivers Pollution Commission occurs this passage: "The importance of the history of water as regards its anterior pollution with organic matters of animal origin does not arise from the presence of the inorganic residues (nitrates, nitrites, and ammonia) of the original polluting matters, for they are in themselves innocuous; but from the risk lest some portion of the noxious constituents of the original animal matters should have escaped that decomposition which has resolved the remainder into innocuous mineral compounds. And the danger is the more to be feared because it is quite impossible by chemical analysis, or, indeed, by any other process of investigation short of administration of the water to human beings, to discover whether or not such noxious substances are still left in the water. We cannot but regard this risk as considerable, whatever may be the nature of the noxious ingredient in excrementitious matters; but if we are to accept the theory which is now prevalent amongst many physiologists who have closely studied the subject of the spread of epidemic and infectious diseases, that these diseases are propagated by minute zymotic germs, the danger becomes much augmented on account of the great resistance which such organic and living germs oppose to the oxidizing agencies which gradually decompose and destroy dead organic matter."

In the words of Mr. Simon, "What one has to do is to guard the supply with utmost strictness against every foul admixture. It should be made an absolute condition for a public water-supply, that it should be incontaminable by drainage."

The water of the brook is supposed to be taken into the pond only at favorable times; but, if it is constantly liable to contamination, who can decide with certainty what is a favorable time? and how can we be sure that the favorable opportunity, if there be one, will coincide with the time of greatest need?

Little Pond, situated between Spy and Fresh Ponds, has an area of thirty-four acres, and is partly bounded by meadows and partly by market-garden lands under a high state of cultivation, which are heavily manured with night-soil.

To quote again from the Final Report of the Pollution of Rivers Commission: "Water collected from the surface or the drains of cultivated land is always more or less polluted with the organic matter of manure, even after subsidence in lakes or reservoirs. Such polluted surface or drainage water is not of good quality for domestic purposes; but it may be used with less risk to health than polluted shallow well-water, if human excrementitious matters do not form part of the manure applied to the land."

The conclusions of the commission on this point, as well as in regard to the question of the destruction of sewage, were reached after a long series of investigations, continued for several years, and covering not only the subjects mentioned here, but also all other questions concerning the relation of water-supplies to the public health.

Spy Pond, in Arlington, contains one hundred and fifty acres, being nearly as large as Fresh Pond. Like Fresh Pond, it has no streams running into it. On the east, are pastures; on the west, highly-cultivated gardens lying on the side of the hill which slopes down to the pond. Here night-soil is used sparingly, if at all; but it is only through Little Pond, where night-soil is used, that the water of Spy Pond can reach the conduit. Spy Pond water is objectionable at present on account of the great amount of microscopic vegetable growth found in it. The same growth (*Clathrocystis æruginosa*) has at times been very abundant in Little Pond, and has also been found to a limited extent in Fresh Pond and the Cambridge reservoir. It is not peculiar to these waters, having been frequently met with in other waters in this vicinity. The conditions which favor its existence are not fully understood; but, when present in large quantities, it

renders the water not only offensive to the eye, but also to the smell and taste, although it is not known to be injurious from a sanitary point of view.

The head of Spy Pond is near the centre of the village of Arlington; and no part of the basin of Wellington Brook, or of Fresh, Spy, and Little Ponds, is more than seven miles from the State House. This proximity to populous centres renders them all liable to increased pollution at no distant day.

Fresh Pond, the largest and best of these various sources of supply, can be most easily protected; but it is a question deserving of the most careful examination, whether either of the other waters can be considered sufficiently safe to warrant their further use. Unless this question can be answered affirmatively, they should be abandoned, and the means of supplementing the supply from Fresh Pond be sought elsewhere.

Notwithstanding the general introduction of water from Fresh Pond, a considerable number of families still continue to drink well-water, obtained in most cases from wells which have been in use for many years.

The evil results which may follow the use of bad well-water have been too often demonstrated to need repetition here. Although there is a great liability to contamination of wells in a city as thickly populated as are many parts of Cambridge, recent analyses of the water from several wells which are still in use fail to show in all cases decided evidence of pollution. Some of them would be classed among the "suspicious" waters; but it cannot be said positively, on evidence of this character, that the soil of Cambridge has been so much polluted as to render the use of well-water always dangerous. Whether it is expedient to use the water from wells under such circumstances, is questionable.

The next table contains the result of analysis of water from six wells in different parts of Cambridge, made by Professor Nichols. With the exception of the Waterhouse-street well, and the tube-well, which are not above suspicion, no one of them can be considered to be free enough from evidence of pollution to be satisfactory as a source of water-supply.

Analysis of Cambridge Well-Waters.

[In parts per 100,000.]

Date.	LOCALITY.	Water as Received.		Solid Residue.			Chlorine.	
		Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° Fahrenheit.		
1877.								
Aug. 30,	Waterhouse St.,[1]	0.0027	0.0067	10.8	3.2	14.0	4.01	
Oct. 6,	Oxford St., ...	0.0035	0.0131	–	–	13.7	1.60	Some nitrates.
Dec. 28,	North Avenue, near Mellen St., .	0.0040	0.0080	28.3	3.9	32.2	4.53	Considerable amount of nitrates.
28,	Columbia St., near Market St.,[2] .	0.0109	0.0125	36.6	5.8	42.4	4.49	Considerable amount of nitrates.
1878.								
Feb. –,	Main St., near Bay St.,[3] . . .	0.0128	0.0037	21.7	0.6	22.3	1.65	Small amount of nitrates.
–,	Cottage St., ...	0.0045	0.0069	17.7	4.7	22.4	3.42	Considerable amount of nitrates.

[1] Large amount of chlorine may perhaps be accounted for by the fact of use of salt around the well to kill weeds.

[2] Old well in use many years.

[3] Tube well.

Water obtained from tube-wells driven to a depth of from seventy-five to one hundred feet is used by several manufacturing establishments, and is said to be satisfactory for their purposes. The domestic use of this water is limited to a very few families.

Lowlands. — While the population was increasing most rapidly, many dwellings of the poorer sort were built on the marsh and adjacent lowlands in different parts of the city. In the years 1873–5 several thickly-populated districts were filled, one to a grade of twelve feet, the others to a grade of thirteen feet, above mean low water, and the buildings thereon raised to the new grade. In 1873 the city authorities ordered that no cellars should thereafter be constructed or maintained below the grade of thirteen feet above mean low water. When the house-lots in these districts were filled to grade thirteen,[1] the streets were raised three feet higher in the expectation that the adjoining lots would be raised by their owners to the same or a greater elevation, in order that their cellars might be below ground.

In many cases, however, the owners have not filled their lands above the grade required by the city; and their lots remain below the level of the streets, thereby preventing the flow of surface-water from them.

In the northern part of the city there are several large clay-pits, some of which are below the level of the tide. In their Fifth Report, the State Board of Health uttered a warning in regard to the danger of allowing the erection of buildings on such sunken areas.

It is likely to be some time yet before any one will propose to occupy this territory; but the great expenditure of money, and the many annoyances caused by the filling of the districts already raised, should have taught the people of Cambridge a lesson not to be forgotten, when any future attempt is made to repeat the experiment of erecting dwellings upon land that is incapable of satisfactory drainage.

Besides the salt-marsh already mentioned, as forming nearly one-third of the area of the city, there are several hundred acres of wet and swampy land which is as yet but thinly inhabited, as it is either remote from business centres,

[1] That is, thirteen feet above mean low-water mark. Mean high-water mark is about grade ten.

or, from its close proximity to the best portion of the city, it is valued too highly to allow of its occupation by the class of population that is usually found in such districts. In coming years, the increasing difficulty of obtaining building-sites on the high and dry land will lead to the occupation of this territory by dwellings, notwithstanding the danger to the residents upon land so full of moisture.

Hitherto, soil-drainage has been accomplished by the indirect action of the sewers, which seem to have permanently reduced the water-level in many localities; but this is not always the case, as in parts of the wet land lying north of Broadway, and east of Oxford Street, the ground-water has again risen, after being materially lowered by the construction of the Oxford-street sewer seven years ago. Until these swampy tracts are permanently dried by the action of the sewers, or by the adoption of some system of underdrainage, they will remain unfit to be occupied by dwellings.

Sewerage. — Before Cambridge was incorporated as a city, in 1846, but one public sewer of any considerable length had been built; and for years after that date, sewers were built here and there to meet the most pressing emergencies, without sufficient regard to the future increase of population, or to the importance of establishing a uniform system of which each new work should form a part. As a result of this method, some of the older sewers are now inadequate to the work required of them: only temporary relief is gained by connecting these with others which are at present less severely tasked.

It would be well for Cambridge, if the whole question of the sewerage of the suburbs of Boston were controlled by one authority. It is nearly impossible for different municipalities, whose interests either are in reality, or are supposed to be, conflicting, to act in harmony with each other in matters in which both are concerned; and our own experience furnishes at least one instance where, for want of such an authority, Cambridge was forced to expend a large amount of money without receiving a corresponding benefit.

A large part of both Cambridge and Somerville lies in the basin of Miller's River; and consequently the natural drainage of that portion of their territory is through that valley. In 1869 Cambridge built a trunk-sewer nearly a mile long,

discharging into Charles River, for the purpose of draining the part of her territory in the Miller's River basin that had previously found an outlet through a stream which originated in Cambridge, and flowed through Somerville into Miller's River. The reluctance of the authorities of Somerville to join in building a sewer which would benefit that town even more than Cambridge, was urged as a reason for the action of the Cambridge city government. Had there been a competent authority empowered not only to consider the present and probable future needs of both places, but also to carry out their recommendations, Cambridge would probably not have built a sewer at a right angle to the natural line of drainage, that should discharge its contents into Charles River at a point three miles farther from the sea than the proper outlet of the territory drained by it.

No injustice would have been thereby done to Somerville, as that city has since been obliged to provide for its own needs by the construction of a main sewer through the Miller's River valley, which passes within a few rods of the head of the sewer built by Cambridge.

Such an authority might also control the discharge of sewage into Charles River by the towns above Cambridge. This is a matter of future, if not of present, interest to Cambridge; for, if the pollution of Charles River by sewage ever becomes excessive, Cambridge, next to Boston, will be the greatest sufferer.

There are now in Cambridge, Dec. 1, 1877, sixty-one miles of sewers in a total of about eighty miles of streets, more than one-half of which have been built within the last ten years. Along the shore of Charles River, there are seventeen sewer-outlets, great and small; two small sewers empty into Miller's River; and three, which are intended to meet the wants of a territory of eight hundred acres, empty into Alewife Brook.

The outlets of all but two of the sewers discharging into Charles River are situated below the level of high water, and are provided with tide-gates. The Binney-street sewer, which is the most important of all to Cambridge, is carried out to low-water mark. In deep water, under Craigie's Bridge, is the outfall of the Bridge-street sewer, which was built at the time of the filling of the basins of Miller's River. This

sewer, although it passes through a part of Cambridge, drains a very small district of the city; but it serves as an outlet for the sewage of a large part of the city of Somerville, including the great slaughtering-establishments, whose drainage in former years contributed so much to the foulness of Miller's River.

The circumstances attending the construction of this sewer show the disadvantages arising from the want of a competent body to plan and carry into execution such works. The joint commission, consisting of the Board of Harbor Commissioners and the State Board of Health, "charged by the Legislature with the duty of devising a plan for the abatement of the Miller's River nuisance," recommended the building of a main sewer, which should empty into Mystic River at a point far removed from any thickly-settled neighborhood. After their report had been received, opposing influences secured the passage of an act of the Legislature, directing that the proposed sewer should be carried through Cambridge, and that its outfall should be under one of the most frequented thoroughfares leading out of Boston.

Near the mouth of this sewer, and within the tide-gates, is a ventilating-pipe eighteen inches in diameter, which extends from the crown of the arch of the sewer to the tall chimney of the Boston and Lowell Railroad machine-shop. This is the only attempt at sewer-ventilation in the city.

When the mouths of the other sewers are closed by the tide, or when the contained air is expanded by the discharge of hot water into the sewer, the only means of exit for the confined gases is through untrapped rain-water conductors, or through the catch-basins or gullies in the streets from which the trapping-water has evaporated.

Such evaporation often occurs in dry weather; and, as there is no provision for regularly filling the catch-basins, the air in their neighborhood is rendered foul by the odors arising from the sewers, and indicating their need of ventilation. By these opportunities for the escape of sewer-air, the liability to its entrance into dwelling-houses through the soil and other drainage pipes is diminished; but to the residents near the catch-basins the annoyance is great.

If the main intercepting sewer for the district north of Charles River, recommended by the Sewerage Commission

of the city of Boston, should ever be built, it would receive the contents of both the Binney-street and the Bridge-street sewers.

House-Drainage. — A city ordinance prescribes that "no private drain shall be connected with a public sewer, except through an intervening catch-basin of brick," the discharge-pipe of which "shall be high enough above its bottom to prevent any thing but the liquid contents passing into the sewer." These private catch-basins are frequently entirely covered with earth; and sometimes their location, or even their existence, is unknown to the occupants of the houses to which they belong. The rule, "out of sight is out of mind," is true in this case; and there is little probability of such basins being emptied until attention is forcibly called to them by the obstruction of the drain or some other equally disagreeable circumstance.

While the entrance of the house-drain into the sewer is thus regulated by law, the matter of the connection of the drain with the fixtures within the house is left entirely to the owner or builder, who may be ignorant of the dangers liable to arise from poor workmanship, and who may be inclined to economize here in order that he may have more to spend on less important but more showy portions of his house.

Except in those cases where complaint has been made of a nuisance existing thereon, no one has been required to connect his premises with the sewer; and as in former years no permission was required to enter a house-drain into the public sewer, and no record made of such entering, it is now impossible to tell how many houses or other buildings have any connection with the sewers.

Two examples will show how the city has failed to reap the benefits which were expected from the large expenditure for sewers, in consequence of not requiring that the drainage of the abutting estates should be made to enter them. The district north of Cambridge Street, bounded by Willow Place, the Somerville line, and the Boston and Albany Branch Railroad, and containing over one hundred houses and a population of eleven hundred, was filled to grade in 1874; and at the same time, sewers were built in every street. That would seem to have been the time to secure proper drainage

for all the estates affected by the change of grade; but up to Sept. 1, 1877, only forty-three permits had been issued to enter the sewers in this district.

In 1873 a dangerous nuisance existed on certain premises in Brighton Street, where there was an accumulation of sink-slops and other drainage matter under the houses. Other premises in the neighborhood were also in great need of drainage. That this nuisance might be abated, a sewer was built in Brighton Street in that year. In November, 1874, the first permit to enter the sewer was issued, and in May, 1875, the second and last. The premises whose condition was the worst have not been connected with the sewer to the present time.

Where no connection with the sewers exists, the drainage usually runs into some kind of a cesspool, which is frequently nothing more than a barrel sunk in the ground. In some cases the old-fashioned cesspools, with walls of uncemented stones intended to allow the escape of their liquid contents into the soil, are still used.

Removal of Night-Soil, House-Offal, &c.—Dec. 1, 1877, there were in use in the city, in dwellings, shops, offices, &c., 3,778 water-closets; of this number perhaps 3,500 were in dwellings, many houses having more than one. It is a common practice in the better class of houses, to place a water-closet in the cellar. It is seldom that these are ventilated, or have any window or other means of direct communication with the outer air. Under such circumstances, foul air from the closet is liable to be distributed over the house; and some persons claim that they can always tell, on entering a house, if there is an unventilated water-closet in the cellar. In the cheaper class of houses, it frequently happens that what is called the "water-closet" is nothing but a hopper into which the waste-pipe from the kitchen sink empties; sometimes even this small supply is wanting, making it necessary to pour water into the hopper to remove the fæcal matter. The condition of such closets can be easily imagined. Some houses are provided with what are known as "sluice-vaults," where the rain-water from the roof of the house, together with the discharge from the house-drains, passes through a brick trough under the seat, and washes the fæcal matter out into the drain and from thence to the cesspool or sewer.

It is probably safe to say that about one-half of the inhabitants of the city, or five thousand families, use the ordinary privy. In parts of the city where privies are most numerous, and stand nearest to the houses to which they belong, their vaults are usually slightly built, and are often nothing more than shallow excavations in the ground, with plank sides. When the planks decay, there is nothing to prevent the soakage of their contents into the ground.

A contractor appointed by the city authorities empties privy-vaults and cesspools at a fixed price; but only when requested by the owner, or when directed so to do by the health-officer in those cases where complaint has been made of the existence of a nuisance. In either case the expense is borne by the owner. During the year 1877, when an average amount of work was done, only 840 vaults and 152 cesspools were emptied by the contractor: besides these, some were emptied by their owners, and their contents buried in the adjoining gardens; but of course such private cleansing was not done in the crowded districts where the privies are most numerous and most neglected, and ought not to be permitted in many cases where it is now allowed. From the above figures it is obvious how little was done in comparison with what was actually needed. The contractor is not obliged to use any form of odorless apparatus, and the work is done with the ordinary night-cart and bucket.

The night-soil is removed outside the city limits, and used upon the numerous market-gardens in the adjoining towns.

House-offal is collected under the direction of the Overseers of the Poor, in covered wagons, which make their general rounds twice a week; restaurants and boarding-houses are visited three times, and fish-markets, &c., four or five times a week. The offal collected is sold to farmers out of the city. From about one-fifth of the houses in the city, no offal is obtained: how it is disposed of in these cases is unknown, as the keeping of swine is forbidden, and is practised only to a very limited extent. Some families probably burn it, and others use it in the feeding of poultry.

Ashes and other dry refuse are collected weekly under the direction of the Superintendent of Streets, and used by him in filling low lands, or sold to private parties for the same purpose.

Dwellings. — A majority of the dwellings in Cambridge are single houses, standing by themselves; cases of two houses having a common roof are not infrequent; but with the exception of some of the poorer tenement-houses, there are few rows or blocks. In 1875 the average number of inhabitants to each occupied dwelling-house was 6.6; in the State at large, the average was 6.4. 7,238 dwelling-houses were occupied by 10,077 families; the number of houses in proportion to the number of families being greater than in most of the cities of Massachusetts.

Public Buildings. — The most important public buildings of Cambridge, from a sanitary point of view, are the schoolhouses. Some of these buildings were built many years ago, but have since been remodelled, while others have been erected but a few years. In nearly all of them, however, improper hygienic conditions are found. In some, a prominent defect is in the method of warming; in others the trouble arises from the location and condition of the privies and urinals; while adequate means of ventilation are wanting in nearly all. Notwithstanding these deficiencies, the condition of the schoolhouses in regard to warming and ventilation is superior to that of other public buildings in the city, upon which greater sums of money have been spent. It is not necessary that each new schoolhouse should be more costly than its predecessors; but it ought, if possible, to be an improvement upon them. It too often happens, however, that, owing to the frequent changes in the members of the city government, the experience gained by one board in the building of schoolhouses is lost to the city when the erection of others becomes necessary. The School Committee, who have the exclusive charge of the schools, and whose term of office is longer than that of the members of the City Council, have no authority in the matter of the construction of schoolhouses.

Dispensary. — A dispensary for the relief of the sick poor is maintained by a private corporation to whom the City Council makes an annual grant of money. The central office is open, for the reception of patients, three times a week; and those who are too sick to visit the office are attended at their homes by one of five district physicians. During the year ending Oct. 1, 1877, 964 persons were treated at the

office, and 4,207 visits were made by the district physicians, to 989 patients.

Hospital. — For several years a hospital for women and children was in existence; but at present it is closed for want of sufficient funds, although the organization is still maintained.

Board of Health. — Heretofore the mayor and aldermen have been the health authorities of the city; but, under the new law relating to this subject, an independent board of health, consisting of three members, one of whom is a physician, has just been established. Good results are anticipated from this change; and it is to be hoped that the people generally will cheerfully co-operate in carrying out any measures which may be proposed by the Board.

IV. — Rates of Mortality.

Registration. — The value of any estimate of the rate of mortality depends entirely upon the accuracy of the registration upon which it is based; and in the discussion of the subject it is important to know, at the outset, how nearly a correct registration of births and deaths has been attained. The city clerk of Cambridge, who acts as registrar, has been in office many years, and thus has the advantage of long experience in his endeavors to make the records complete. Judging by what has recently been published concerning the non-enforcement of the registration laws throughout the State, it is probable that there are few cities or towns in the Commonwealth where the registration of deaths is more accurate than in Cambridge.

The greatest deficiencies are found in the registration of births. In a few instances parents comply with the law, and make immediate returns of the births of their children. The names of infants dying under the age of one year, who are reported by the undertakers to have been born in Cambridge, are entered in the list of births. During the month of January in each year, three men are employed to visit every house, and record the names of all children born during the preceding year. Usually they fail to obtain the names of children born in families who have removed from the city before the first of January. The information thus gained is supplemented, when possible, by other means; as, for example, by the examination of parish registers.

When an undertaker omits to file a physician's certificate with his return of a death, his attention is at once called to the omission, that it may be rectified. In the last few years, certificates signed by the medical attendant have been actually obtained in about ninety-five per cent of all deaths registered. It must be admitted that errors and indefinite statements occur too frequently in these certificates; but the number of those which are signed by persons of no medical education is small.

In the accompanying table, are shown the annual death-rates of the city for eighteen years. In calculating this table, as well as those which follow, still-births have been omitted, and also those cases in which persons who died elsewhere were brought to Cambridge for burial and their names entered on our records.

The population for the years when no census was taken was estimated in the manner referred to on page 334.

Annual Death-Rates of Cambridge for Eighteen Years (1860–77, *inclusive*).

YEARS.	Number per 1,000 of population.	YEARS.	Number per 1,000 of population.
1860, . . .	18.61	1869, . . .	17.18
1861, . . .	21.99	1870, . . .	20.23
1862, . . .	18.79	1871, . . .	19.48
1863, . . .	21 25	1872, . . .	24.78
1864, . . .	22.25	1873, . . .	21.68
1865, . . .	19.13	1874, . . .	23.96
1866, . . .	17.73	1875, . . .	23.28
1867, . . .	16.55	1876, . . .	19.97
1868, . . .	18.70	1877, . . .	19.82

The mean rate for the whole period is 20.2; the high rates of the years 1872–74, and 1875 are noticeable. In 1872 the mortality was large throughout the State; and in 1874–75 scarlet-fever prevailed extensively in Cambridge.

The average annual death-rate of Boston is considered to be 24.5 per 1,000. How the death-rate of Cambridge compares with the rates of some of the other cities in the State, is shown in the next table, taken mainly from the Report on the Sanitary Condition of Lynn, published in the Eighth

Annual Report of the State Board of Health. In this list are included all the cities of Massachusetts containing twenty thousand inhabitants.

	Population in 1875.	Death-rate.*		Population in 1875.	Death-rate.
Cambridge, .	47,838	20.2	Lynn, . .	32,600	19.4
The State, .	1,651,912	19.2	Lawrence, .	34,916	19.1
Worcester, .	49,317	22.4	Springfield, .	31,053	18.9
Lowell, . .	49,688	22.2	Chelsea, . .	20,737	18.8
Fall River, .	45,340	21.8	Taunton, .	20,445	17.6
Salem, . .	25,958	20.4	New Bedford, .	25,895	17.3
Somerville, .	21,868	19.6			

* Mean of the years 1866 to 1875 inclusive.

Seven of these cities have a lower death-rate than Cambridge; the three cities whose population is most nearly equal to the population of Cambridge have death-rates considerably higher. These figures are favorable to Cambridge; but it will be seen farther on, how much the death-rate is affected by the exceptional healthfulness of a part of its population, and also what a large part of the mortality of Cambridge is due to causes which are, to a great extent, preventable.

Mortality at Different Ages. — The most important inquiry under this head is in regard to the mortality among infants and young children. In the table below, calculated for the two census years 1865 and 1875, is given the mortality at certain ages in Cambridge in comparison with Boston and the State.

Deaths per 1,000 *at Specified Ages.*

		1865.	1875.
Cambridge,	Under 1,	243.2	269.4
	Under 5,	69.7	100.7
	Over 5,	12.0	13.0
	All ages,	19.1	23.2
Boston, .	Under 1,	265.5	275.8
	Under 5,	92.9	86.8
	Over 5, .	15.6	18.8
	All ages,	23.6	26.1
The State,	Under 1,	205.2	226.5
	Under 5,	68.7	77.7
	Over 5, .	14.9	14.8
	All ages,	20.6	21.1

It has been shown elsewhere [1] that a high rate of infant-mortality prevails in Boston; and it appears from this table that the same is true to a less extent of Cambridge, although the extremely high figures of 1875 are probably largely due to the prevalence of scarlet-fever and diphtheria. Great as was the mortality in 1875 among the children of Cambridge under five years, it was exceeded in two cities, — viz., Fall River and Lawrence, where the rates per thousand living were respectively 104.3 and 114.9.

Another way of estimating infant-mortality is by ascertaining the ratio between deaths under one year, and registered births. By reason of the omissions in the record of births, the results obtained in this manner appear to be more unfavorable than if all the data could be obtained; but, as some similar omissions may be supposed to occur in Boston, a comparison between the two cities is not unfair.

The application of this rule to Cambridge gives the following results.

	Percentage of Deaths under one year to Births.		Percentage of Deaths under one year to Births.
1865, ...	14.4	1872, ...	23.5
1866, ...	12.7	1873, ...	19.6
1867, ...	13.2	1874, ...	23.2
1868, ...	13.6	1875, ...	23.8
1869, ...	13.6	1876, ...	17.5
1870, ...	18.0	1877, ...	16.9
1871, ...	15.7		

The mean ratio of deaths under one year, to births registered each year in Cambridge, from 1865 to 1877 inclusive, was 17.3; or, in other words, for every hundred births there were annually 17.3 deaths of infants under the age of one year. In Boston the mean ratio from 1865 to 1874 was 19.6, the highest ratio being 23.3 in 1872. In Cambridge, for the same term of years, the mean ratio was only 16.7; but in 1872 the ratio was 23.5, slightly larger than that of Boston. For the five years ending with 1869, the mean ratio was 13.5; for the five years ending with 1877, it was 20.2.

[1] Report on the Sanitary Condition of Boston, by Dr. T. B. Curtis. 1875.

A third method of estimating infant-mortality is to ascertain the percentage of deaths under one year, and of deaths under five years, to deaths at all ages. The results of this method appear below.

		Percentage of Deaths under one year to Total Deaths.	Percentage of Deaths under five years to Total Deaths.
Means of five years,	1865–69, ...	23.9	42.5
	1873–77, ...	26.9	46.4

By either method of calculation, it appears that of late years the rate of infant-mortality has increased.

Mortality of Different Races. — After the extended discussion of the comparative mortality of natives and foreigners, in the Report[1] of the Medical Commission appointed by the Board of Health of Boston in 1874, it is considered to be unnecessary to enter upon it here, as the population of Cambridge bears a close resemblance to that of Boston in the proportion of the native to the foreign-born inhabitants, and in the preponderance among the latter of the Irish element.

Among the colored population the rate of mortality is very high. In 1875 they numbered 1,103, while the average annual mortality among them from 1872 to 1877 inclusive was forty-four, which is equal to a rate of forty per thousand. Diseases of the lungs were the leading cause of death.

V. — Prevailing Diseases.

Of a total of 13,752 deaths in Cambridge during the last eighteen years (1860–1877), 4,116, or 29.93 per cent, were caused by the zymotic diseases, or those which are considered to be to a greater or less extent due to removable causes. How much the general death-rate of the city is affected by the prevalence of these diseases, is seen in the table below, where the general death-rates, and the death-rates by eight[2] of the principal zymotics, are compared.

[1] Referred to on the previous page.

[2] Small-pox, scarlet-fever, diphtheria (including croup), measles, diarrhœal diseases, cerebro-spinal meningitis, typhoid-fever, and whooping-cough.

	Death-Rate.			Death-Rate.	
	General.	Zymotic.		General.	Zymotic.
1860, . .	18.61	5.37	1869, . .	17.18	5.31
1861, . .	21.99	5.25	1870, . .	20.23	5.41
1862, . .	18.79	6.01	1871, . .	19.48	5.07
1863, . .	21.25	6.24	1872, . .	24.78	7.62
1864, . .	22.25	6.56	1873, . .	21.68	6.04
1865, . .	19.13	4.50	1874, . .	23.96	7.18
1866, . .	17.73	4.45	1875, . .	23.28	7.48
1867, . .	16.55	4.03	1876, . .	19.97	5.66
1868, . .	18.70	5.19	1877, . .	19.82	6.40

These diseases will be considered in order, beginning with the cause of the greatest mortality. At the head of the list stand the

Diarrhœal Diseases. — These are recorded under the names of diarrhœa, dysentery, cholera, cholera-morbus, and cholera-infantum, cases of the last being by far the most numerous. Together they have caused 1,863 deaths; a percentage to the total mortality of 13.54, and to the zymotics of 45.2. The mean number per thousand of the population, for the period under consideration, was 2.75.

The proportion of deaths from these diseases, to the whole number of deaths from all causes, has been increasing of late years. In the five years ending with 1864, 10.91 per cent of the total mortality was due to these diseases; and, in the five years ending with 1877, 13.53 per cent.

The number of deaths to each thousand of the population for the last four census years was as follows: viz., 1860, 1.91; 1865, 2.57; 1870, 3.40; 1875, 3.11.

The six deaths reported as cases of cholera occurred in the summer of 1866. A man and his wife died in one house, and four persons in another in the same neighborhood. In the latter case, the house was found to be in a filthy condition from lack of proper care and drainage: in the former, as far as could be learned, the condition of the house and its surroundings was good.

Scarlet-Fever. — To this disease, including eighteen cases of "scarlet-rash," are ascribed 719 deaths; or 5.23 per cent of the total mortality, and 17.4 per cent of the mortality

from zymotic diseases. Mean rate per thousand of the population, 1.09. In 1866 no deaths from scarlet-fever were reported; in 1874, 110; and in 1875, 108. Since the year 1859 it has caused nearly eight times as many deaths in Cambridge as small-pox. In former years there were no restrictive regulations whatever in regard to this disease; but in May, 1877, the School Committee adopted a rule prohibiting the attendance at school of any child living in a house where small-pox, scarlet-fever, or diphtheria exists.

It is not an easy matter to enforce such a rule at once through the agency of teachers; but it is believed that so far it has been tolerably well carried out. As its enforcement becomes more thorough, it is to be hoped that good results will follow; but a rule of the School Committee can only forbid the actual attendance at school of children from houses where the disease exists, while they are at liberty to mix freely with other children everywhere else.

As far as possible, complete isolation should be insisted upon; and in view of the great mortality from this disease, and the liability to permanent impairment of the health which may follow it, it would seem that but little persuasion should be necessary to induce the community to submit cheerfully to any regulations which might be thought necessary by the Board of Health. In addition to the cases of scarlet-fever enumerated above, twenty-eight deaths are recorded under the names of "angina maligna" and "malignant" or "putrid sore throat."

Probably some of these should be placed under the head of scarlet-fever, and others be classed with the diseases next on the list: viz., —

Diphtheria and Croup. — Whatever may be the ease or difficulty of distinguishing between these diseases in practice, it is impossible to separate them satisfactorily in the records. 594 deaths are ascribed to them; a percentage to the total mortality of 4.32, and to the zymotics of 14.4. The mean number per thousand of population is 0.88. Cases have been reported in every year; but the maximum was reached in 1876 during the epidemic of diphtheria, which, beginning in 1875, has not even yet passed. In 1875, 1876, and 1877, diphtheria and croup caused 248 deaths, or 8.16 per cent of the entire mortality for those years.

Typhoid-Fever. — This disease has caused 290 deaths; a percentage to the whole number of 2.11, and to the zymotics of 7.0. The mean number per thousand of the population was 0.44. During the period under consideration, notwithstanding the increased use of Fresh Pond water and the extension of sewers in all parts of the city, the mortality from typhoid-fever has not diminished. For the first nine years, the mean number per thousand of the population was 0.40; for the last nine years it was 0.47. The greatest number of deaths in any one year was thirty-three, in 1872.

Whooping-Cough. — To this disease are attributed 143 deaths; or 1.04 per cent of the total mortality, and 3.5 per cent of the mortality from the zymotic diseases. In this number are probably included cases where death resulted from other diseases occurring as complications of the whooping-cough.

Erysipelas stands next on the list, with 103 deaths; a percentage of 0.75 to the total mortality, and to the zymotics of 2.5.

Small-Pox caused ninety-two deaths in the eighteen years; or 0.67 per cent of the whole number, and 2.23 per cent of the deaths from zymotic diseases. Sixty-six deaths occurred during the epidemic of 1872–73. The provisions of law in regard to the vaccination of children before their admission to the public schools are strictly enforced.

Measles. — Seventy-one deaths from measles are recorded; a percentage to the total mortality of 0.51, and to the zymotics of 1.72.

Cerebro-Spinal Meningitis. — Only eight deaths from this disease were recorded before the year 1873, when the number ran up to thirty-five. The total for the eighteen years is sixty-five; or 0.47 per cent of all deaths, and 1.58 per cent of the deaths from the zymotic diseases.

Rheumatism. — To this disease are credited fifty-one deaths, some of which are specified to be due to the valvular disease of the heart, consequent upon the rheumatism.

Puerperal-Fever is assigned as the cause of fifty-five deaths during the eighteen years.

Seven deaths are attributed to purpura, and one each to carbuncle and malignant pustule.

Alcoholism and Syphilis. — Only seventeen deaths are

ascribed to alcoholism in as many years, and six deaths to syphilis from 1872 to 1877 inclusive. Would that these figures truly represented the entire mortality from these causes! but too often the importance of correct registration is lost sight of in the desire to save the reputation of the deceased, or to spare the feelings of his friends.

In connection with the subject of syphilis, it may be said that Cambridge has always been remarkably free from houses of ill-fame; but its proximity to Boston affords abundant opportunity for the contraction of venereal diseases, which are not uncommon, even among certain of the better portion of the population.

Outside the class of diseases that have just been considered, the most important position is occupied by diseases of the lungs, which have caused 22.9 per cent of the entire mortality since the year 1859.

Pulmonary Consumption.—As will be expected, this disease stands at the head of all causes of death. The number of deaths from consumption during the eighteen years was 2,006, or 14.59 per cent of the total mortality. For the period named, the mean number per thousand of the population was 3.06.

There has been apparently somewhat of an improvement in the consumption death-rate; as is shown by the fact that for the first five years of this period this disease caused 15.7 per cent of the whole number of deaths, and for the last five years only 13.9 per cent.

The lessened rate per thousand living appears in the following table, calculated for the last four census years.

Death-Rates from Consumption for Four Census Years.

	Percentage of total mortality.	Number per 1,000 of population.		Percentage of total mortality.	Number per 1,000 of population.
1860, . .	18.89	3.68	1870, . .	15.51	3.17
1865, . .	17.21	3.40	1875, . .	12.56	2.92

Much of this diminution may be due to greater accuracy in diagnosis, by which deaths which would formerly have

been charged to consumption are now more correctly assigned to other diseases.

It is evident that the conditions which favor the development of this disease exist to a marked degree in some quarters of the city, as will be seen in the comparison of the rate of mortality from consumption in different districts.

Acute Lung Diseases. — Including under this head, pneumonia, pleurisy, bronchitis, lung-fever, and congestion of the lungs, and a few cases of "disease of the lungs," we have 1,155 deaths, or 8.4 per cent of the whole mortality.

The mean number of deaths per thousand of the population for the eighteen years is 1.7; for the first five years the mean number per thousand is 1.56, and for the last five years 2.06. In 1875 these diseases caused a mortality of 2.71 per thousand, of which one-half occurred in January, February, and March. The mean temperature of this year was less than that of any preceding year of our series, the months above mentioned being particularly cold.

VI. — Health of Different Districts.

For the purpose of comparing the rates of mortality in different localities, during the six years ending Dec. 31, 1877, the city has been divided into ten districts, which are indicated on the map by red lines with their numbers in Roman numerals.

This period was chosen for the reason that deaths occurring before 1872 could not be definitely located, because houses were not generally numbered until 1871.

In each year, however, there were some deaths — more at first than afterward — which were necessarily omitted on account of the impossibility of deciding certainly to which district they belonged. In defining the districts, it was intended that each one, as far as possible, should have tolerably well marked characteristics in regard to soil, and quality of inhabitants, and the division of the population should be nearly equal.

For the population, the census of 1875 was taken as a basis; it being assumed that the rate of increase for the years before and after 1875 was uniform throughout the city.

The number of inhabitants in each district was estimated

from an enumeration of the dwellings contained therein; and we know that in 1875 the average population of Districts I., II., and III., was 4,550; of Districts IV., V., VI., VII., and VIII., 4,812; of Districts IX. and X., 4,865. The results of this examination would have been much more valuable if the comparison could have been made between smaller areas with a view to show the differences existing between neighborhoods but a short distance apart. Although these differences do exist, it is impossible to show them satisfactorily without an enumeration of the population for this special purpose, which was impracticable.

In estimating the population of Districts I. and X., the inmates of the Almshouse and of the penal institutions at East Cambridge were not counted; in the tables, deaths occurring in those institutions were omitted.

The district lines were determined before the records of deaths were examined.

District I. contains the highest land in the city, and also some of the lowest, viz., the meadows near Alewife Brook. Geologically it consists in a great part of brick-clay, with bowlder-clay in the territory east of Walden Street. Along the line of North Avenue are gravel-beds; and on the west, peat-swamps of mixed marine and fresh-water origin. As a whole it is very thinly inhabited, a large part of its area, including the meadows, being almost entirely vacant. About one-third of the population is of foreign birth, including Irish and Canadian French.

District II. is almost wholly made up of gravel-beds, except that the tops of Observatory and Reservoir Hills consist of clay. At the foot of Observatory Hill is a peat-swamp, probably of considerable depth; and there are superficial tracts of a similar character near Langdon Street and Kirkland Street. These last probably rest on deposits of sand.

The population of this district is nearly all native-born, well-to-do, and living in the best class of houses. The college grounds are in District II., and a large proportion of the whole number of students is included in its population.

District III. — Gravel-beds extend over the district between Main and Mount Auburn Streets, and between Harvard and Brattle Squares. Along the river and also between Lowell and Willard Streets are marine peat-marshes. This last-named territory, together with that known as the "Cow-

perthwaite-street District," where are found deposits of brick-clay, was filled and raised to the grade of thirteen feet above mean low water in 1874.

Most of the district is thickly inhabited: there is a large foreign element in the population, but it includes more of the students of the college than any other district except II.

District IV. — The eastern half of this district is chiefly composed of gravel-beds; in the west, bowlder-clay covers the high land; and between Maple Avenue and Inman Street are extensive deposits of brick-clay. With the exception of a few localities, the population is chiefly native-born, in comfortable circumstances.

District V. — The broken line on the map shows how much of this district consists of salt marsh. The territory between Green Street, Pleasant Street, and Western Avenue, extending west of Bay and Howard Streets, was filled to grade thirteen in 1874–75. The rest of the district is made up of gravel, except that clay is found on the sides of the hills between Main Street and Putnam Avenue and the marsh. The dwellers on the marsh and filled land are almost wholly of foreign origin; in other parts of the district, the population is largely composed of mechanics and others in fair circumstances.

District VI. is chiefly composed of gravel-beds and marine peats, the former lying between Magazine and Brookline Streets, and including the territory near Fort Washington formerly known as "Pine Grove;" the latter covering the rest of the district, and encroaching upon the gravel between Auburn and Hamilton Streets. The marsh-land is not yet built upon to any extent. The character and circumstances of the population are similar to those of District V.

District VII. — No part of this district is over ten feet above mean high water. In the west is a tract of gravel; but the whole of the eastern extremity, with a strip lying along the line of School Street, is composed of marine peat-swamp. In 1873 a large amount of filling was done east of Moore Street, to raise the land to grade twelve. This district is thickly inhabited. In Washington Street and its neighborhood, on the filled territory, live four-fifths of the colored population of the city, and there are also many foreigners.

District VIII. — Near the junction of Webster Avenue and Plymouth Street are beds of fine sand; north of this is a

large deposit of brick-clay; and the rest of the district, exclusive of a strip of gravel on the western border, is made up of marine peats. The territory north of Cambridge Street, and between Webster Avenue and the Boston and Albany Branch Railroad, was filled to grade thirteen in 1874. Here are to be found some of the largest tenement-houses; and all the settled portions of the district are thickly inhabited, mainly by persons of foreign birth or descent. Much of the brick-clay land is vacant.

Districts IX and X.—Nearly all the inhabited portion of these districts consists of bowlder-clay, and the remainder of salt-water peats. Almost one-half of the people are foreign-born; and, taken as a whole, the population of these districts is more crowded than in any other part of the city of equal extent.

The total number of deaths which could be credited to the districts in which they occurred was 5,445; and their distribution is exhibited in the next table. If all the deaths which were omitted could have been assigned to the proper localities, the unfavorable showing of some of the districts would have been increased, as most of these cases were of persons of foreign birth or parentage; and in numerous instances, while the exact locality could not be learned, it could be ascertained that the deceased lived in one of two of the worst districts. Thus a death reported from East Cambridge must have occurred in District IX. or X.; but, unless its exact locality could be discovered, it was omitted.

If we could institute a comparison between the districts in regard to their infant-mortality, it would no doubt prove interesting and suggestive; but this can only be partially done, for want of the necessary knowledge of the age-distribution of the inhabitants of the several districts.

If it were possible to have an accurate registration of prevailing diseases, it would be of great assistance in the present inquiry. By it we could learn if sickness is really as much more frequent in some districts than in others, as would appear from the number of deaths; or how much greater mortality results from an equal number of cases in those districts where unsanitary conditions are most common.

The following table shows the total *known* mortality of each district, and the number of deaths per thousand of the population.

	1872.		1873.		1874.		1875.		1876.		1877.		Six Years.	
	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.
I., ...	95	23.3	87	20.6	86	19.6	65	14.2	77	16.7	66	14.3	476	18.1
II., ...	39	9.6	49	11.3	60	13.6	53	11.6	47	10.2	43	9.3	291	10.9
III., ...	79	19.4	82	19.4	77	17.5	93	20.4	87	18.9	52	11.3	470	17.7
IV., ...	60	13.9	51	11.4	85	18.3	87	18.0	79	16.2	75	15.4	437	15.5
V., ...	89	20.1	74	16.5	94	20.2	110	22.8	100	20.5	108	22.2	575	20.4
VI., ...	78	18.1	62	13.9	65	14.0	83	17.2	71	14.6	71	14.6	430	15.4
VII., ...	110	25.6	120	26.8	129	27.8	177	36.7	126	25.9	136	27.9	798	28.4
VIII., ...	130	30.2	119	26.6	150	32.3	132	27.4	101	20.7	110	22.5	742	26.6
IX., ...	75	17.2	70	15.5	108	23.0	115	23.6	102	20.7	100	20.3	570	20.0
X., ...	109	25.1	100	22.1	128	27.3	119	24.4	94	19.1	106	21.5	656	23.2

It must be remembered that this is only a comparative statement, and by reason of the omissions, the death-rates given in the table for all the districts appear considerably lower than they are in reality.

In the next table is given the number of deaths known to have occurred in each district from six principal diseases, with the death-rate attributed to each.

Districts arranged in the Order of their General Death-Rate.	Phthisis.		Acute Diseases of the Lungs.		Diarrhœal.		Number of Deaths.			[1] No. per 1,000 of the population.
	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	No. of Deaths.	No. per 1,000 of population.	Scarlet-Fever.	Diphtheria and Croup.	Typhoid-Fever.	
VII., ...	99	3.42	103	3.56	125	4.32	36	49	12	3.35
VIII., ...	111	3.84	78	2.70	130	4.50	43	39	10	3.18
X., ...	119	4.07	62	2.12	112	3.83	44	23	10	2.63
V., ...	79	2.73	65	2.24	62	2.14	43	29	10	2.84
IX., ...	94	3.22	42	1.45	81	2.77	30	30	11	2.43
I., ...	67	2.45	41	1.49	64	2.34	28	14	16	2.12
III., ...	55	2.01	51	1.97	86	3.15	23	22	8	1.97
IV., ...	56	1.93	40	1.38	51	1.87	25	34	16	2.59
VI., ...	46	1.59	56	1.93	61	2.11	21	21	11	1.93
II., ...	33	1.21	32	1.17	22	0.80	14	13	6	1.21

[1] Death-rate from scarlet-fever, diphtheria and croup, and typhoid-fever.

Upon a comparison of their general death-rates, the several districts stand in much the same relation to each other as might have been expected; with perhaps an exception in the case of District III., which has a higher place on the list than that to which its situation and the general character of its population would seem to entitle it.

The extremely low rate of District II. is very noticeable; but even if we omit that district on account of its exceptional character as regards population, we find two other districts in which the death-rate is but little over one-half the rate of District VII. How much the high rates prevailing in Districts VII., VIII., and X., tend to increase the general death-rate of the city, is plainly shown in the first table; and it must be remembered that these rates only represent the average of the whole district. In each there are localities where the rate is much higher. Thus the rate of District VIII. in the table is 26.6 per thousand; while in that part of the district included between Warren Street, Cambridge Street, and Willow Place, the average rate for the last six years is nearly 32.

Among the chief causes of disease in these last-named districts, are the improper habits of living of many of their inhabitants, due to their poverty and ignorance. These habits cannot be immediately changed by any outside influence: improvement in these respects can only be expected to come with better circumstances and increased knowledge.

At first the efforts of the public health authorities must be mainly directed to the improvement of their surroundings, and to the prevention of the spread of those contagious diseases which are fostered, and, as it were, kept alive, in such localities; but even in this limited sphere there is abundant opportunity for sanitary work.

The filling of the lowland districts was begun as an important health measure; but, if any improvement has followed the raising of these lands, it does not plainly appear from these figures, unless the diminished rate in Districts III. and VIII. is to be taken as evidence of such a result. On the other hand, Districts V. and VII. show an increased rate for 1876 and 1877 over the rate of 1872.

A partial statement of the mortality among young children will be found in the following table, giving the number

of deaths of persons under five years of age, and the percentage of the entire mortality.

This is of comparatively little value unless we can also know what is the proportion of children under five years to the whole population in a specified locality: yet it gives some idea of the enormous infant-mortality in certain districts.

DISTRICTS.	Deaths under five years.	Per cent of total mortality.	DISTRICTS.	Deaths under five years.	Per cent of total mortality.
I., . .	226	47.4	VI., . .	183	42.5
II., . .	79	27.1	VII., . .	384	48.1
III., . .	223	47.4	VIII., . .	426	57.4
IV., . .	152	34.7	IX., . .	307	53.8
V., . .	245	42.6	X., . .	335	51.0

Extended comments on the second table are unnecessary. Both tables should be read in connection with the map and the descriptions of the districts on preceding pages.

In the second table the districts are arranged in the order of their general mortality, District VII., having the highest death-rate, being placed first; but, if they were re-arranged according to the mortality from either of the principal causes of death, they would stand in very different relations to each other.

Among the points worthy of notice are: —

1. The large number of deaths from phthisis in the first five districts. The population of all these districts is largely made up of persons of foreign descent, and much of their territory is low land.

District III. resembles them in these respects; but its mortality from phthisis is exceeded by that of District I.

2. The high mortality in District VII. from acute diseases of the lungs. This recalls what was said above in regard to the mortality of the colored population, which is chiefly found in this district.

3. As a rule, the districts having a high death-rate from diarrhœal diseases show also a high rate from phthisis; but District III., where the mortality from phthisis was below the average, occupies the fourth place in the column of diarrhœal diseases.

4. The apparent want of any connection between scarlet-fever and diphtheria. Although these diseases have both prevailed in an epidemic form during these years. some districts which have a high mortality from the one have a low mortality from the other. In 1875 and 1876 Districts I., II., and III. were comparatively free from diphtheria, while it prevailed extensively in all other parts of the city. In 1877 the mortality from diphtheria in these districts exceeded that of both of the preceding years, while in other districts the disease was declining.

5. The deaths from typhoid-fever are distributed very evenly throughout the city. This disease has not prevailed, or at least has seldom proved fatal, on the marsh-lands. Most of the deaths have occurred in wet and poorly-drained localities on the upland.

The impossibility of making comparisons between a number of small districts in regard to their mortality has prevented the bringing-out as clearly as could be wished the special causes of disease; but sufficient has been said to show, if further proof were needed, in addition to what has been so often demonstrated elsewhere, the coincidence of excessive mortality with bad hygienic conditions, whether the latter arise from natural causes or from ignorance or carelessness.

VII. — Concluding Remarks.

To sum up what has already been said: —

1. The natural disadvantages of Cambridge, as a place of residence, are due to the large amount of impervious soil and marsh-land, and the slight elevation above high tide of a great portion of its area.

To overcome these, there are required more attention to soil-drainage, care in the location and construction of sewers, and the prohibition of the erection of dwelling-houses in any section of the city below a grade which will insure proper drainage.

2. The question of the future water-supply of the city is one of great importance. We cannot afford to run any risk of the deterioration of our present source of supply by the addition of other waters; and their use should not be permitted without a thorough investigation, in the light of the best sanitary knowledge, into their liability to present and future

AM. PHOTO-LITHO. CO. N.Y. & BOSTON (OSBORNE'S PROCESS.

pollution. If our present supply should become contaminated by the addition of impure water, it might then be too late to remedy the evil; and the possibility of the great loss to the city, which would ensue, should prevent any final action without full consideration.

3. In order to realize all the benefits which may reasonably be expected from the building of sewers, their use should be made compulsory. At the same time that the connection of private drains with the public sewers is required, a strict supervision should be exercised over the whole system of house-drainage, in order that the advantages of the sewer-connection may not be neutralized by faulty workmanship within the house.

4. So long as privies continue to be used, a more frequent and systematic cleansing than is now practised should be required, and every care taken to make this work as inoffensive as possible. Modern improvements make it practicable to reduce the difficulty of this to a minimum.

It has been shown above, that, while our death-rate cannot be called excessive for a city as large as Cambridge, yet there are districts where the mortality is very great. The insanitary conditions of these districts are a constant source of danger to the rest of the city, by reason of their favoring the development of certain diseases, which, if not directly caused by filth, are at least intensified by it, and which, having obtained a foot-hold in these localities, are liable to extend to remote neighborhoods through the various means of infection. Every effort should be made to improve the condition of these districts, not only in the hope of reducing their death-rates, but also as a measure of protection for the whole city.

While special attention is given to these districts, the other parts of the city must not be neglected; for undoubtedly there will be found, even in the best neighborhoods, sources of danger, the existence of which is unsuspected, but which may at any time cause an outbreak of disease.

Although at present the population seems stationary, yet, judging from our past experience, we may expect that an improvement in financial affairs will be followed by a steady increase of population, perhaps not so rapid as in former years, but sufficiently large to necessitate greater attention

to sanitary matters; for with the increase of population will come an increased liability to many forms of preventable disease.

The recent organization of an independent Board of Health is a long step in the right direction; and if every citizen who is interested in the prosperity of Cambridge will co-operate with the Board, and, so far as he is able, endeavor to remove from his own premises whatever possible sources of disease may exist thereon, we may confidently look for an improvement in the sanitary condition of the city.

HEALTH OF TOWNS.

HEALTH OF TOWNS.

Our correspondents report this year an unusual condition of health, generally speaking, throughout the State. Diphtheria has been prevalent and fatal in many localities, and whooping-cough has been epidemic to a considerable degree in various towns: erysipelas has also been noted. Other diseases are reported, as a rule, not to be more prevalent than usual, — generally, less so. The following are the replies of our correspondents, giving the results of their own experience, and also that of other physicians in their respective towns, so far as has been practicable. In a few cases of the quite small towns, the replies are from the selectmen, there being no resident physician.

Replies of Correspondents.

Abington. — (3,241 — 41.)[1] Small-pox, no cases. Measles, no cases. Scarlet-fever, a few mild cases during summer and autumn. Cerebro-spinal meningitis, no cases. Diphtheria, only one case, at North Abington. Croup, no cases. Whooping-cough, a few mild cases. Erysipelas, unable to recall or learn of any cases. Typhoid-fever, only two cases, one of which proved fatal. Diarrhœal diseases, very few, and mild in character. Rheumatism, only a very few mild cases. Acute pulmonary diseases prevailed only to a very small extent.

Less sickness in this vicinity than any year since 1863. The ordinary summer complaints of children have hardly been heard of. During the summer I saw two clearly-marked cases of scarlet-fever in one family; the patients being a boy of six years, and a girl of eight years, in both of whom I saw the disease as well marked four years ago.

Acton. — (1,708 — 21.) The health of this town has been good during the past year. There has been no prevailing disease, except, perhaps, in September there was considerable dysentery in some parts of the town, but of a mild character, yielding readily to treatment.

Amesbury. — (5,987 — 59.) Small-pox, no cases. Measles, no cases. Scarlet-fever: an occasional case occurred during the first half of the year. This fall there prevailed a mild epidemic; all cases getting well of the primary disorder, and a few dying of Bright's disease following.

[1] Population by the census of 1875; and deaths, as reported to the Secretary of State, for 1877, and kindly furnished by him.

Cerebro-spinal meningitis, no cases. Diphtheria, *very* few cases. This month (December) four members of one family were attacked, of whom two died, — one infant, one adult. Croup, very few cases. Whooping-cough prevailed to a moderate extent in the warm part of the season. Erysipelas, very few cases and mild. Typhoid-fever, more than for the previous few years; mostly confined to a square fifteen rods by fifteen rods, which is entirely devoid of sewers. Diarrhœal diseases have not prevailed to great extent. Rheumatism, a few cases of chronic and mild acute: Acute pulmonary diseases: the number of these has also been small.

In fact, the health of this community has been very good right through the year. There would be left on the list of deaths very few, were those resulting from chronic diseases excluded.

Andover. — (5,097 — 73.) No small-pox. Measles to a great degree have been through the town, being disseminated from one family to another by the public schools. No epidemic of scarlet-fever. I can think of only one family in which this disease existed; and this family was isolated, so the disease did not spread. No cerebro-spinal meningitis. No diphtheria or croup of a fatal character. Whooping-cough seemed to prevail in company with measles. One or two cases of erysipelas of a mild character. No typhoid-fever. Diarrhœal diseases were present in the autumn, but in mild form. Rheumatism in the spring was frequently observed, perhaps rather more so than for a few years past. Bronchitis and pneumonia less than usual.

Andover has passed a year when sickness in the town has been unusually mild in form, seldom in occurrence.

Ashburnham. — (2,141 — 43.) No small-pox. A few mild cases of measles; nothing especially noticeable in the circumstances. Scarlet-fever confined to five or six families; cases generally mild, although two or three were marked by quite extensive diphtheritic membraneous deposits. No fatal cases; no epidemic. One case of cerebro-spinal meningitis has been reported, — a child eight or nine years of age, not under my care; proved fatal. There have been scattered cases of diphtheria. No epidemic; no fatal cases. Very little croup. There were a few cases of whooping-cough early in the season; but, during 1875 and 1876, it was very prevalent, nearly every person liable to take the disease being affected by it. There were a few scattered cases of erysipelas; no epidemic. There have been fewer cases than usual of typhoid-fever. Diarrhœal diseases were somewhat prevalent during the hot weather, but no fatal cases. There have occurred only the usual number of cases of rheumatism, and these mainly of a sub-acute or chronic nature. There have been no fatal cases of pneumonia or acute bronchitis. One or two deaths occurred in elderly people from acute, supervening upon chronic, bronchitis. During a part of the year acute catarrhal disturbances were quite prevalent.

There has been nothing remarkable in the occurrence of disease during the year. There has been no epidemic of serious nature, whooping-

cough having nearly exhausted the material upon which to work before the commencement of the year. There have been two deaths from acute brain-disease, — one acute "hydrocephalus," and one acute "cephalitis;" the two cases living near each other, in a low, damp place, and amid unhealthy surroundings.

Ashby. — (962 — 20.) With the exception of scarlet-fever, we have had but little acute disease during the past year. In March and April we had a mild form of scarlet-fever, invading two-thirds of the families where there were children; and, although the attack was slight, in many cases it was followed by troublesome rheumatism. From typhoid-fever we have for another year been nearly exempt, only one case coming under my observation. The general health of the town has been good.

Athol. — (4,134 — 59.) No small-pox. A few cases of measles. A few sporadic cases of scarlet-fever. No cerebro-spinal meningitis. A few cases of diphtheria, perhaps six or eight, and one death. A few cases of mucous croup. Whooping-cough very prevalent among children and adults. A very few cases of erysipelas. Six or eight cases in all of typhoid-fever. Diarrhœal diseases as usual in the summer months. A few cases of rheumatism. No special type of acute pulmonary diseases prevalent.

The past has been an exceptionally healthy year in this vicinity; rate of mortality lower than for several years past. The only prevalent epidemic has been whooping-cough.

Attleborough. — (9,224 — 129.) Small-pox, no cases known to the reporter; probably none have occurred. Measles, series of cases at intervals through the year. Scarlet-fever has occurred during the year in a sporadic form, but not of a serious type. Not many cases of cerebro-spinal meningitis; two fatalities. Isolated cases of diphtheria, with small mortality. Croup not prevailing. Whooping-cough, a large number seized in December. Erysipelas slight. Typhoid-fever for the last three years far less prevalent than formerly. Diarrhœal diseases not in large numbers. Rheumatism frequent. Instances of pleuro-pneumonia; cases of croupous and catarrhal pneumonia frequent.

Probably less illness than in prior years. Relative immunity from typhoid-fever and diphtheria, probably attributable to the general use of pure water, introduced in 1874. Each succeeding year appears to corroborate this opinion. Perhaps, however, a larger series of observations is necessary for the formation of a conclusive opinion. The known superiority of the water affords an improved sanitary condition, which must eventually be supplemented by adequate sewers. The laws of health are better observed than formerly, and rational principles of diet and general hygiene more thoroughly applied and enforced among the well and the sick than before. Pursuant to former request for specimens of suspected drinking-water, I send some drawn from well supplying a house where malignant diphtheria exists. The barn-cellar, into which sinks and privy discharge, is about thirty feet from well; soil, porous gravel, with

underlying sand. Several cases of fatal scarlatina occurred in the house fifteen years ago, since which there has been no unusual sickness. Sinks have always been untrapped, except by movable disks over outlet; the barn-cellar, with its influx, has existed but two years. [Prof. Nichols's examination of the water referred to shows a dangerous amount of pollution, as may be seen by the following figures, in parts per 100,000.]

Ammonia, . . .	0.0072	Organic and Volatile,	3.8
Albuminoid Ammonia,	0.0140	Total at 212° F., .	14.9
Inorganic, . . .	11.1	Chlorine, . . .	2.4

[Slight blackening occurred on ignition; and there was a small amount of nitrates; that is, slight test with sulphate of iron in unconcentrated water.]

Auburn. — (1,233 — 23.) There have been 17 deaths in our town the past year. No particular disease prevailing; quite a large number of old persons in the list. Our town is very healthy, not able to support a physician. One came among us last year, but he was obliged to leave again last fall.

Barnstable. — (4,302. — 68.) No small-pox. I have seen no measles. A few cases of scarlet-fever in early spring, mild; a few cases in December, none fatal, excepting one in village of Barnstable, with diphtheritic complication. No cerebro-spinal meningitis to my knowledge. No diphtheria in this village (Hyannis); some in Barnstable. No croup except sporadic. A few mild cases of whooping-cough. Very few mild cases of erysipelas. A few cases only of typhoid-fever have occurred in the town; one severe case evidently from local filth causes. Very few cases of diarrhœal diseases. But few cases of rheumatism. Some acute pulmonary disease, but less than ordinary seasons.

The general health in this community has been very good, more so, I think, than in ordinary years. We have had no epidemic. In this village (Hyannis) we have no surface moisture, and very little decayed vegetation: the soil is thin, sandy loam, underlying which is loose, coarse gravel of interminable depth. A heavy rain very soon disappears from the surface, and we always have dry walking. The houses and yards are neat and well policed; and if no privy-vaults or cesspools were allowed, and the sink-drainage and slops were carried away from the vicinity of the wells and utilized, in my opinion our village and vicinity would stand at the head of the list of places in New England, if not in the country, as a sanitary resort in summer-time, or from June to November. The prevailing wind, which is quite constant, is south-west, and comes directly from the Vineyard Sound.

Ayer.—(1,872—40.) Small-pox not at all. Very few cases of measles, if any. There have been isolated cases of scarlet-fever in town during the whole year: it has not prevailed as an epidemic, strictly speaking. The cases have not been confined to any particular portion of the town, and have been very mild as a rule. In one large new house, built over the ashes of a very old one (recently burned), there have been in six months, in three families, ten cases. It had affected every child in the house *once*, and has just proved fatal in the *second* attack to the child which had it first. No cerebro-spinal meningitis. Diphtheria has been quite prevalent during the year. (See remarks.) Isolated cases of spasmodic croup, none of the membraneous variety. In two families of 3 and 6 children, it has passed through the entire families; was quite mild during the day, with severe exacerbation at night. A few cases of whooping-cough throughout the town, and in a little village of about six houses, in the easterly part of the town, it has appeared in nearly every family, attacking adults as well as children. Only a few cases of erysipelas. Very little typhoid-fever; mild, isolated cases. Diarrhœal disease less than common; a few cases of cholera infantum, but nothing like an epidemic. There was some dysentery during the early summer, but it yielded very readily. I do not think there has been a case of acute rheumatism in town during the year. There have been less acute diseases of the lungs than usual, especially among the children. This form has carried off quite a number from among the older residents.

There has been less sickness than usual throughout the year: there have been cases of scarlatina as mentioned, measles, variola, mumps, but nothing like an epidemic; would not, as a rule, appear in two adjacent houses, but in isolated families. Diphtheria has prevailed to a greater extent than any other disease; but, as mentioned with others, it has been in families, and I do not know of an instance where it has occurred in adjacent houses. It has been quite fatal; in one family taking all (three children), in another three of the youngest members, and in a number of others one or two. These cases have occurred in the best classes of society as well as the poorest, upon high land and low land, sandy pine land and heavy oak land, and seemingly as fatal in one as the other. In the first family mentioned above, the house and surroundings, its situation as to drainage, the condition of the cellar, the manner of conducting the sink-drainage from the house, situation and condition of privies, were in as good hygienic condition as they well could be.

Barre.—(2,460—45.) Not any small-pox. Only a few cases of measles. Scarlet-fever prevailed to a considerable extent for this town; cases generally of mild form, with but little fatality; affections of throat light, with few exceptions; anasarcous sequelæ more frequent. No case of cerebro-spinal meningitis in my practice, and none heard of. Only very few cases of diphtheria succeeding scarlet-fever. I do not think there have been half a dozen genuine cases in town. Have heard of no croup. No whooping-cough in 1877. No erysipelas in my practice. No typhoid-fever. Only a few sporadic cases of diarrhœal diseases, mainly among children. No rheumatism of acute nature. I have seen only a

few cases of bronchitic character. No pneumonia, and heard of only two or three cases in others' practice.

The health of this town for 1877 was exceptionally good. We have had nothing looking towards an epidemic save a little flurry of scarlet-fever in the spring and winter preceding, as related.

Becket. — (1,329 — 16.) No well-marked cases of diphtheria. Whooping-cough prevalent in the eastern section of Middlefield during the summer and autumn. Three cases of erysipelas in Middlefield last winter, not very severe. Typhoid-fever not prevalent, but a few severe, grave cases. (See remarks.) A few cases of diarrhœal disease during the latter part of summer. Four cases of rheumatism in Middlefield last February and March.

Typhoid-fever broke out in an Irish family in the east part of Middlefield last August. The first case was that of a young man, twenty years of age, who came home from Peru, where he had been stopping a few days with a family sick with typhoid-fever (whether more than one case or not I have not learned). This young man had rather a severe course of the fever, but recovered. Next, a younger brother, at work on a farm in Becket, was at home a few days while his brother was sick, became ill, went home and had the fever, and recovered. Then another brother, aged 11, was taken down, and died Oct. 12. Still another, aged 8, had the fever, and died Oct. 17. The father, aged about 50, died Nov. 6. The wife and mother had a light course. Six of the family had the fever, one-half of whom died. The dwelling is an old, one-story wooden house, — one of the oldest buildings in town. The barn stands about eight rods from the house, north, the ground sloping from it towards the house. The privy is about half that distance, on the same slope. The well is on the north and back side of the house, and, at the time of the sickness, was very low. House-slops are frequently thrown into the back-yard. The earth is raised about the well, so that surface-water does not run into it; but that, of course, does not prevent infiltration and permeation through the subsoil. Now, although the first case might have been caused by contagion from the family in Peru, I think it more than probable that the cases which followed were caused, or at least aggravated, by the condition of the water. The soil in that part of the town is damp, but the fever commenced in a time of great drought. There were no other cases in the neighborhood, and but two other cases in town, and they were remote from each other. No apparent cause for these.

In the fore part of September the wife of G. H. F. of Chester, just over the Middlefield line, was taken sick with typhoid-fever. The case was well marked, but ran a rather light course. A young man, a farm-hand, 19 years of age, was taken down when Mrs. F. began to convalesce, and died in a few days. Then Mr. F. was taken sick, and died in ten days after he took to his bed. Mr. F. was a farmer, 26 years old, a stout, robust, intelligent young man. The house and surroundings were kept very neat; but the water was bad, and, I do not hesitate to say, was the cause of the fever.

Belchertown. — (2,315 — 43.) Small-pox not at all. Not any measles. Not any scarlet-fever. Cerebro-spinal meningitis not at all. Very few cases of diphtheria, and mostly of a mild form. Several cases of spasmodic croup; none of membraneous. Whooping-cough very extensively, and of a severe form for so mild a disease. Erysipelas very slightly. Few cases of typhoid-fever, and of a mild character. Diarrhœal diseases, cases few, and all recovered but three or four children. Rheumatism slightly. A large number of cases of acute bronchitis this fall. Very few cases of pneumonia.

Less sickness in town than any year for the past ten years.

Bellingham. — (1,244, — 25.) There have been no cases of small-pox. There were something less than twenty cases of measles, most of which were mild in character, and did not require medical attendance: all recovered. The number of cases of scarlet-fever have been a little more than twenty (22 or 23). Most of the cases were of a mild type: all recovered but one, who is now convalescing. This last was the only "grave case" in the whole number. Not a case of cerebro-spinal meningitis. There have been fifteen well-marked cases of diphtheria, beside others where the symptoms were less marked. Only one of these approached the malignant type: this case was fatal. One other case was fatal. There have been but very few cases of croup; none fatal. I do not think I saw a case of whooping-cough during the year. But very few cases — one case of phlegmonous erysipelas was particularly severe, three separate abscesses forming; but the case terminated favorably. But one or two cases of typhoid-fever, mild. Diarrhœal diseases did not prevail extensively, though several were very severe. I recall among the severe cases one in a child sixteen months old, who was nursed from a bottle, and two in old ladies; two of the three barely pulling through. Rheumatism has prevailed slightly, though some of the cases were quite severe: I speak particularly of cases of the articular variety. Acute pulmonary diseases have not prevailed extensively. I have had but one case of croupous pneumonia, fatal. Acute bronchitis has been the most prevalent of these diseases, but the cases have not been fatal. I recall one case of capillary bronchitis in a child; which was, as usual, severe, though he made a good recovery. I recall but one case of consumption.

Of the diseases named on the preceding pages, it will be seen that measles, scarlet-fever, diphtheria, acute bronchitis, and diarrhœal diseases have prevailed the most extensively. There have been, however, but comparatively few deaths from these diseases. Still, on the whole, there has been more sickness than during the year 1876; but the cases have, for the most part, been mild. Chicken-pox is prevailing slightly at present. Typhoid-fever seldom prevails to any great extent in this town. Rheumatism (articular) is not common, and cerebro-spinal meningitis is almost unknown. This being a country town, we do not suffer from overcrowding, foul-smelling tenements, etc., which are incident to many large towns; consequently, as a rule, such diseases as measles, scarlet-fever, and for the most part diphtheria, are not of the grave or malignant type seen in many places. Small-pox has not prevailed here since the spring of 1872.

Berkley. — (781 — 15.) No small-pox. Very little measles. No scarlet-fever that I have heard of. There has been no cerebro-spinal meningitis. Quite a number of cases of diphtheria. Very little croup. Very little whooping-cough. A few cases of erysipelas. Very little typhoid-fever. Diarrhœal diseases not prevalent. A few cases of rheumatism. There were many cases of acute pulmonary diseases last winter and spring; none this fall or winter thus far.

It has been quite sickly in Berkley during the past year; and yet there has been no prevailing epidemic, unless I might say that pneumonia and diphtheria have been so. I have had more cases of apoplexy than common this winter. Diphtheria also begins to be more prevalent than it was last year. Derangement and diseases of the digestive organs have been more prevalent in my practice than previously.

Berlin. — (987 — 21.) No small-pox. No measles. Few cases of scarlet-fever, generally mild; nothing peculiar in circumstances. No cerebro-spinal meningitis. No diphtheria. No well-marked case of croup. No whooping-cough. No typhoid-fever. I do not know of any well-defined case of typhoid-fever; some cases of simple fever. Here and there a case of rheumatism. Acute pulmonary diseases very rare.

There has been a very general prevalence of good health the past year. One case of hydrophobia from the bite of a dog, after three months' incubation; wound not cauterized till four hours after its reception; patient lived about five days from the attack; aged 26; male; no sleep for the time; general excitement; highly nervous; could swallow powders with difficulty; also ice-water caused spasms. Conversed quite rationally good part of the time; pulse rapid; saliva viscid, frothy; no opiates had any sensible effect, even when injected under the skin; terror and alarm at times when persons passed before him or offered him any thing. Sat up in bed part of time, being held by an attendant around the stomach at his request; at last, in a spasm, springing up, he exclaimed, "O God! I am dying," and expired.

Bernardston. — (991 — 21.) Whooping-cough has prevailed to some extent in a mild form. A very few cases of typhoid-fever have occurred, but not as an epidemic; and they were not the result of any known cause.

This town has been quite free from epidemic disease during the year. Nothing has occurred that could be of any interest to you in making your report, except the fact that the town has been free from fatal epidemics, yet the number of deaths has been proportionally large. In the list, old age comes often, and consumption not infrequent.

Beverly. — (7,267 — 126.) No small-pox. No measles. Scarlet-fever occasionally, for most part very mild, occasionally a malignant case, rarely fatal. No cerebro-spinal meningitis. Diphtheria quite frequent, mild, yielding readily to treatment, rarely fatal. Croup rare, not fatal. Whooping-cough frequent, but not epidemic. Erysipelas occasionally. Very few cases of typhoid-fever; only one fatal case that I know of; don't think there have been a dozen cases. Diarrhœal diseases rare and

mild. Rheumatism not frequent. Acute pulmonary diseases occasionally, mostly sub-acute. Some influenza or catarrhal fever, not epidemic.

I should say the town had been very healthy; typhoid and diarrhœal disease growing less and less every year since the introduction of Wenham water. We have had no epidemic disease.

Billerica. — (1,881 — 29.) No small-pox. No measles. One case of scarlet-fever. No cerebro-spinal meningitis. One case of diphtheria only proved fatal. Two cases of croup, light. No whooping-cough. Erysipelas slight. Three cases of typhoid-fever, one fatal. Three cases of dysentery. Rheumatism and acute pulmonary diseases slight.

Blackstone. — (4,640 — 40.) No small-pox. A few cases of measles in November and December. A few cases of scarlet-fever of a mild form. No cerebro-spinal meningitis. Some fifteen cases of diphtheria, two deaths. No croup to my knowledge. We have had quite an epidemic of whooping-cough during the summer and fall, and it is now prevailing; but one fatal case, that of a child three months old. Erysipelas to no great extent. A few cases of typhoid-fever during the fall, generally of a mild character. Very little of diarrhœal diseases. Very little rheumatism. Much less of acute pulmonary diseases than usual.

It is the opinion of the oldest physicians in this vicinity that the past year has been the most healthy of any within their knowledge.

Boston. — (341,919 — 7,316.) The marked decline in the death-rate of Boston in 1877 indicates a period of unusual health. The number of deaths registered at the office of the City Board of Health for the past year is 7,316, which is nearly 1,000 less than that of 1876; and with an assumed population of 353,000[1] gives a reduced mortality rate of 20.72 to the 1,000 living. This is 3.12 less than the rate of the preceding year, and 4 less than the mean general death-rate of Boston for twenty-five years past.

The causes that have led to this result may be attributed to the remarkable freedom during the year from epidemic influences, which, if we except diphtheria, were far less than usually active; to the comparative mildness of the winter, and the equableness of the temperature generally throughout the year, as will be seen by the following table; and to the decline in immigration; to which may be added the efficient action of the City Board of Health.

[1] The population has been estimated by calculations from the census returns of 1865, 1870, and 1875; by the births and deaths for the twelve years past; by the yearly polls since 1865, and by the statistics of immigration and emigration.

TABLE I. — *Deaths and Meteorology for 1877.*

	Average Number of Deaths Weekly.	Mean Temperature.	Average Daily Range of Temperature.	Average Weekly Range.	Relative Humidity.	Fall of Rain in Inches.	Prevailing Winds.	Number of Deaths per 1,000 Living.	Deaths per 1,000 in 1876.	Death-rate in New York in 1877.	Death-rate in London in 1877.
Year, . .	141.5	–	–	–	–	51.29	–	20.72	23.84	24.67	21.37
1st Quarter, .	132.7	30.7	16	36.2	72.2	13 57	W.	19.52	26.2	24.40	23.56
2d Quarter, .	124.1	55.2	16.7	34	67.6	10.29	E.	18.27	20.9	22 48	20.25
3d Quarter, .	178.1	68.7	16.3	30	73.6	7.65	S. W.	26.23	27.4	30.02	19.34
4th Quarter, .	131.6	44.2	16.5	35.3	65.9	19.78	W. and N. W.	18.79	21.0	21.81	22.35

It will be noticed that the weekly average number of deaths was 17.1 less than in 1876; and that the mean temperature was two degrees higher, and the mean daily range one degree less than in that year, — facts that may partially account for the diminished mortality from the diseases of the respiratory organs that prevail during the colder months. By far the largest mortality was, as usual, in the third quarter, the period of diarrhœal diseases. The average weekly mortality in the fourth quarter, it appears, was considerably below that of the corresponding period in the previous year. The recorded mean temperature was also seven degrees higher than in the fourth quarter in 1876. It will also be noted that the death-rate for 1877 was 0.67 less than that of London, and nearly four less than that of New York.

Of the seven principal diseases of the zymotic group, which have generally so largely contributed to swell the mortality rates, there were two, small-pox and measles, from which, as last year, but six deaths are recorded.

The number of deaths from scarlatina was 104, or less than a quarter of the number registered in 1876. The death-rate was 1.40 per cent of the whole mortality, against 5.52 in the preceding year, and 4.91, the mean for the preceding ten years. This sudden decline in the mortality from this disease is not improbably due, in part at least, to the efforts of the city Board of Health in more rigidly enforcing a provision of the General Statutes for the more perfect isolation of scarlet-fever patients. A circular was issued by that board early in the year, with recommendations to this effect, and suggesting such hygienic measures as would tend to check the spread of the disease. The disease proved most fatal in the first four months of the year, as had been previously noted. The lowest mortality was in August and September.

From diphtheria, the deaths were fewer than in the two preceding years; although the disease was unusually prevalent throughout the year. The number of deaths was 361, against 575 in 1876, and 420 in 1875. As will be seen by the table below, the largest mortality was in the third quarter, the mortality rising again as the year advanced.

Croup, although often grouped with diphtheria, but distinct in its causes, progress, and consequences, is not here included. From this disease there were 97 deaths, against 132 in 1876, and 214 in 1875.

Whooping-cough proved more fatal than in the preceding year; the deaths being 89 against 58, or 1.21 per cent of the whole mortality against 0.70.

The deaths from the diarrhœal diseases, taken together, constituted a much larger per cent of the whole, owing, doubtless, to the lessened general mortality, than the average of the previous ten years; being 12.48 against 7.94.

The mortality from cholera infantum alone, as appears from the registrar's report, was in excess of that in 1876; being 567 against 542. It will be noticed by the table, that the mean temperature for the third quarter, when this disease is most prevalent, was 1.6 higher than in the preceding year.

Typhoid-fever was the cause of 156 deaths, or .04 of the whole number.

This is the mean death-rate from this disease since 1851. The largest mortality was in September and October.

The whole number of recorded deaths from all zymotic diseases was 1,714, against 2,443 in 1876, more than one-fourth of the whole mortality.

A still further decline in the relative mortality from phthisis is apparent from the returns. As has been remarked in former reports, this disease has been steadily on the decline for several years, as appears from the following table: —

TABLE II. — *Showing the Deaths from Phthisis per* 1,000 *for the Five Census Years and since.*

1850.	1855.	1865.	1870.	1875.	1876.	1877.
4.28	4.57	4.22	3.98	3.86	3.60	3.52

It is by no means improbable that this decline in the death-rate from phthisis is due in part to the turn in the tide of immigration during the last two years. It appears from the returns, that the number of immigrants during that period has fallen off from 13,468 in 1875 to 5,765 in 1877. This reduction in a class of the population that contributes so largely to the mortality from this disease must of necessity affect its general death-rate.

The whole number of deaths from pneumonia was 448, against 518 in 1876. This is 6.12 per cent of whole mortality, against 6.27 in the previous year. It was most fatal in March.

There was also a decline in the prevalence of bronchitis, from which 205 deaths were recorded, against 226 in 1876. The largest mortality from this disease was also in March.

Table III. — *Mortality of Boston in 1877.*

		January.	February.	March.	April.	May.	June.	July.	August.	Sept'r.	October.	Nov'r.	Dec'r.	Total Deaths.	Per centage to whole Mortality.	Deaths to 1,000 Living.
Total Deaths, . . .		564	544	615	577	572	464	792	806	719	566	550	547	7,316	–	20.72
Under 1, ...		129	122	114	97	121	91	301	273	250	128	106	90	1,822	24.90	5.16
" 5, ...		220	207	222	186	208	154	453	403	377	207	187	180	3,004	41.05	8.50
Total Zymotic Diseases,		91	89	97	69	66	73	336	330	256	128	94	85	1,714	23.42	4.85
Principal Zymotic Diseases.	Small-Pox, . .	1	–	–	–	2	1	–	–	–	–	–	–	4	0.05	0.01
	Measles, . . .	–	–	1	–	–	–	–	1	–	–	–	–	2	0.02	0 01
	Scarlatina, . .	27	8	14	17	10	7	4	3	–	5	5	4	104	1.40	0.29
	Diphtheria, . .	36	41	37	27	31	27	19	12	18	32	30	42	361	4.93	1.02
	Croup, . . .	11	11	15	7	4	1	5	1	8	11	6	17	97	1.32	0.24
	Whooping-Cough, .	8	9	4	5	4	5	10	12	14	8	5	5	89	1.21	0.25
	Cholera Infantum, .	1	–	1	1	4	16	212	181	125	17	8	1	567	7.75	1.60
	Total Diarrhœal, .	4	13	17	6	10	21	287	285	187	64	14	5	913	12.48	2.58
	Typhoid Fever, .	4	7	9	7	5	11	11	16	30	27	17	12	156	2.13	0 44
Marasmus, &c., . .		19	10	12	11	15	11	24	39	31	17	18	10	217	2.96	0.61
Phthisis, ...		103	94	107	130	111	81	100	104	109	81	111	105	1,235	16.86	3.52
Pneumonia, . . .		54	36	64	55	40	23	17	12	20	24	51	52	448	6.12	1.26
Bronchitis, . . .		23	23	28	23	14	11	7	8	12	18	16	22	205	2.80	0.58
Deaths in Institutions, .		74	83	89	67	69	56	79	81	72	83	88	60	901	12.31	2.55
Deaths over 70, . .		67	70	57	67	62	34	51	69	44	52	47	56	676	9.24	1.91

The deaths of children under one year of age, which are so marked a feature of our mortality records, were nearly four hundred less than in the previous year, being 1,822 against 2,213. The diminished birth-rate for 1877 will not alone account for this lessened mortality; for it appears from the Registration Reports that the percentage of deaths to births during that year was considerably lower than for many years, being only 17 against 18.91, the mean for the fifteen years immediately preceding. The deaths of children under five were 3,007, against 3,563 in 1876. Included in this estimate are the deaths reported as occurring at St. Mary's Infant Asylum in the Dorchester District. It appears from the records of that institution, that, out of 230 patients treated there during the year, there were one hundred deaths under one year of age, and 118 under five; being more than fifty per cent of the whole number, or at the rate of 513 per thousand living. These fearful statistics are suggestive, and have been more than once noticed by the City Board of Health.

"Such a mortality," says the last Report, "amounting to a rate of 461 per thousand (nearly one-half of all the inmates, and twenty times the rate of mortality for the city at large at all ages), not only suggests that some most unwholesome, and, as we believe, not altogether unpreventable, conditions are at work in an institution whose natural advantages of location are exceptional, but actually affects the general mortality rate among infants in the city as a whole, and by so much helps to give Boston a bad name. We cannot help feeling, that, if the authorities of St. Mary's Infant Asylum would supplement the charitable purposes of the founders of that trust, and apply rigid hygienic regulations concerning the overcrowding of sleeping-rooms, the preparation of food, and the preservation of cleanliness, they would find their vital statistics less open to unfavorable comment."

Although the mortality in the above institution is not in excess of that in many other similar institutions in the country, the experience at the Foundling Hospital at Bonn shows what may be accomplished by a carefully regulated regimen. In that institution, founded in 1873, the mortality in the first year was at the rate of sixty per cent, which is above that of St. Mary's. This, by a stricter hygienic management, especially in connection with the preparation of the food, was reduced in the following year to nine per cent.

It has been difficult to ascertain with accuracy the comparative mortality rates in the different portions of the city, in consequence of the want of correspondence between the systems of division into districts adopted by the State and City Boards of Health, and the ever-changing boundaries of the wards. The following table, however, gives an approximate estimate of the population, area, and death-rates in the twenty-five wards, and is arranged so as to include the nineteen districts[1]

[1] I. East Boston, above Porter Street: mostly high ground, well drained; inhabited by a prosperous people of the middle class. II. East Boston, below Porter Street: low ground; in some parts densely inhabited, with many blind alleys, tenement-houses, and wet cellars; foreign-born predominate. III. Charlestown: a range of hills, with territory sloping to water north and south;

adopted by the City Board of Health, many of these being co-terminous with the wards: —

TABLE IV. — BOSTON. — *Population, Area, and Deaths per 1,000 in the different Wards in 1877.*

HEALTH DISTRICTS.	Wards.	Estimated Population.	Area in acres.	Population per acre.	Deaths per 1,000.	Deaths per 1,000 in 1876.
I., .	1	14,376	1,099.75	13.07	15.16	17.7
II., .	2	15,930	449.87	35.67	20.46	19.8
III., .	3	11,527	170.	67.57	17.87	20.0
	4	11,514	242.	47.57	18.06	
	5	11,602	130.75	88.73	18.27	
IV., .	6	18,231	139.	131.16	22.65	28.2
V., .	7	12,840	65.67	195.52	22.27	23.9
VI., .	8	12,489	48.	260.18	22.90	23.9
VII., .	9	12,985	81.	160.30	19.11	26.1
	10	10,768	94.	114.55	14.20	
VIII., .	11	14,306	470.33	30.41	12.93	14.1
IX., .	12	15,323	146.	104.95	22.57	26.1
X., .	13	22,384	228.	98.17	21.30	27.9
XI., .	14	19,304	518.	37.26	14.71	20.9
XII., .	15	14,212	429.	33.13	17.08	22.3
XIII., .	16	15,131	64.25	235.50	18.30	19.4
XIV., .	17	14,182	102.60	138.22	14.24	16.3
	18	13,478	100.70	133.94	11.27	
XV., .	19	19,309	148.60	129.93	20.09	22.3
	22	15,846	666.	23.80	17.79	
XVI., .	20	11,909	636.60	18.72	18.70	20.5
	21	12,342	1,080.	11.42	22.28	
XVII., .	23	12,714	6,386.	1.99	19.82	17.6
XVIII., .	24	13,898	4,762.	2.91	17.42	21.2
XIX., .	25	6,400	2,343.	2.71	15.93	15.8
		353,000	20,581.12	–	–	–

generally well drained; inhabitants nearly equally divided between native-born and foreign-born. IV. The "North End," east of Salem Street, and north of Prince Street: densely inhabited with an improvident population crowded in tenement-houses. V. The "Old Mill Pond," a section of which Haymarket Square is the centre: filled territory, and poorly drained; inhabited by lower classes in insanitary dwellings. VI. Leverett-street District: inhabited by lower and middle classes, upon poorly-drained soil, some of it

It will be seen from the above table that the highest death-rates were in the sixth, seventh, eighth, twelfth, thirteenth, and twenty-first wards, portions of the city, for the most part, marked by one or more of those general conditions which conduce to these results, — a largely foreign population, more or less crowded into badly-built tenement-houses, low or wet land, and inattention to the ordinary rules of health. The North End, the "Old Mill-Pond" District, South Cove, South Boston, and the Ruggles-street District will be recognized by the sanitarian as familiar ground. The highest death-rate was in Ward 8, where the population is also most dense. The comparatively high death-rate in Ward 21 is probably exceptional.

The influence of the above-named conditions on the mortality rates appears in the following extract from a letter to the State Board of Health of Dr. M. B. Leonard of East Boston: —

"There have been thirteen deaths from scarlet-fever during the year. Ten of these were upon marsh-land and in houses where the sanitary conditions are undesirable. One of the three that died upon the upland came under the observation of the writer. There were serious defects in the drainage of the house, and the case terminated in diptheritic croup.

"Four of the five deaths from cerebro-spinal meningitis were upon upland.

"There were thirty deaths from diphtheria, against seventy-four in

filled land; not specially overcrowded. VII. Beacon Hill: high land, good drainage; excellent class of dwellings and inhabitants, except in a limited area upon the northern slope. VIII. The "Back Bay," north and south of Commonwealth Avenue, and west of Arlington Street: "made land," of clean gravel, but inhabited by an excellent class, in modern expensive dwellings. IX. The "South Cove:" in all respects, as regards soil, drainage, dwellings, and people, an unhealthy district. X. South Boston, below E Street: inhabited densely by mechanics and laborers, largely foreign-born; drainage fair. XI. Dorchester Heights and City Point: high, natural territory, overlooking the harbor, and exposed to the free action of uncontaminated winds; soil sandy and well drained; inhabitants thrifty; not crowded. XII. Washington Village: low, and in parts "made land;" people of the middle and lower classes; drainage fair. XIII. The territory between the Boston and Albany Railroad and Milford Street, embracing the recently-raised Suffolk-street section, and the district in which are Seneca Street, Rochester Street, and Oswego Street: mostly "made land;" occupied by a mixed Irish and German population; drainage good in the newer territory, very bad in the other. XIV. "Boston Neck," between Milford and Camden streets, and east of Warren and Columbus avenues: thickly settled with thrifty inhabitants, in good dwellings; territory too low for good drainage in some parts. XV. The Ruggles-street District: low, poorly-filled territory, badly drained, and inhabited by an unthrifty class, mostly foreign-born, and indifferent to measures for promoting health. XVI. The territory upon and around Mount Pleasant and Mount Warren, in Roxbury: high, well drained; inhabited by an intelligent and prosperous people. XVII. West Roxbury: sparsely settled, outlying territory, approaching a rural character. XVIII. Dorchester: much like the last. In many parts the water service has prematurely gone before the sewers. XIX. Brighton: rural in character. Formerly objectionable on account of its numerous slaughter-houses, but now in most respects desirable for residences.

The death-rates for 1876, in the table, are taken from the Fifth Annual Report of the Boston Board of Health, p. 31.

1876. Of these one hundred and four cases, forty-one were upon the upland and sixty-three upon marsh land; the death-rate per thousand inhabitants for the two years being 3.1 on the natural soil, and 4.43 on the low lands.

"In June and July there were over thirty cases and seven deaths in a cluster of houses near the junction of Chelsea and Bennington Streets. These houses were built, within a few years, in a mud-hole where the sewers are so badly constructed as to make it impossible to obtain good drainage. The construction of the drains in the houses was more imperfect, if possible, than the sewers. In the cellars of some of the houses, the contents of water-closets and sinks, and decaying vegetables, were found mixed with the mud and water.

"Between the 26th of October and the 5th of November, four deaths occurred in one family on Lexington Street. The house is nearly new, and the surroundings in every way desirable. Inspection, however, revealed serious defects in the drainage of the house. In every case of diphtheria the writer has seen, he has found sewer-gases more or less constant in the rooms. In several houses he has found the drains and sewers admirable. The traps to waste-pipes, however, proved imperfect, and allowed at times a free passage of sewer-gases into occupied rooms.

"Five cases of croup and diphtheritic croup were reported, four of which were upon the low lands.

"The four deaths from whooping-cough were all upon marsh land.

"There were twelve deaths from typhoid-fever, nine of which were upon marsh land. The remaining cases were in houses where sanitary rules are not observed.

"Of the sixty-seven deaths from diarrhœal diseases, forty-four were upon low lands and twenty-three upon the uplands; the most of the latter being in undesirable neighborhoods.

"There were thirty-five deaths from pneumonia and bronchitis, twenty-three of which were in the low lands."

Consumption appears to have been more prevalent than in the preceding year, a hundred and three deaths against sixty-six.

The most unhealthy portion of East Boston seems to be that below Porter Street on low ground, in some parts densely inhabited, with many blind alleys, tenement-houses, and wet cellars; while that portion above Porter Street is high, well drained, and inhabited by a prosperous people of the middle class.

In the Brighton District, it is stated by Dr. H. E. Marion that "diphtheria has been confined mostly to one street, among the poorer classes with very unfortunate surroundings; in many instances the sink-water running off on the surface of the ground, all sorts of refuse at times thrown from the windows, privies poorly constructed, &c."

With regard to the general sanitary condition of Boston, although little progress has yet been made towards carrying into effect the suggestions of the commissioners on sewerage, three years ago, the work may be said to have been begun. Preparations for laying the proposed sewers are being made; and the laying out of the Back Bay Park, to comprise a hundred acres or more, will soon be commenced. There are still parts of

the city, however, that demand the special attention of the sanitary authorities. In the last report of the City Board of Health, two nuisances are brought to the notice of the city government, which have long been borne with commendable meekness by the suffering inhabitants in their vicinity. One is that portion of the Back Bay near the mouth of the Stony-Brook Sewer ; and the other, the Roxbury Canal, an enormous open sewer, in which, says the report, "the sewage and mire lie a fathom deep, bubbling their gases through the black putrid waters," and this in the midst of a thickly populated section of the city, in which also the City Hospital is situated. The report mentions a large number of dwellings as unfit for occupancy at the South End, in consequence of cellars constantly wet from tide, sewage, or surface water. In more than a hundred houses along the banks of Stony Brook, the cellars were flooded by its waters when high. It is understood that measures are being taken to improve the upper portion of the Stony Brook territory : but nothing has as yet been done towards removing the other sources of ill-health and discomfort; and during the coming season, as in years past, every breeze that blows from the west will come more or less laden with the pestilential vapors that have so long brooded over the Back Bay Flats.

On the whole, the city has reason to congratulate itself on its measure of health, as indicated by the low death-rate of the past year. It has been well said that epidemics are warnings to mankind ; and it especially becomes the city of Boston, after the fearful visitations of the last few years, to prepare for another incursion of those dread messengers whose periodicity cannot be calculated.

Boxborough. — (318 — 5.) No small-pox. Very few cases of measles. Very few cases of scarlet-fever; not fatal. Seven cases of cerebro-spinal meningitis, one very severe but not fatal. No diphtheria. A few cases of croup. Whooping-cough has prevailed as an epidemic, but has not required much medical attention. Erysipelas has not prevailed, but there have been isolated cases. Frequent cases of typhoid-fever, but confined to no locality and I can trace it to no physical cause. Diarrhœal diseases have not prevailed to any great extent. Frequent cases of acute and chronic rheumatism, but it has not prevailed. Lung-fevers with children are quite frequent. A few cases of pneumonia in adults; not very prevalent.

Among the cases of interest is that of a family of three children who were taken sick at nearly the same time, the characteristic symptoms being those of typhoid-pneumonia, although very unusual and not seeming quite clear. I at once suspected some difficulty in drainage, or impurity in water, and found, upon examination, that within less than twenty feet were two privies and two sink-drains, and they all depended towards the well. The water had a sensibly unwholesome smell; and, upon boiling, it had been noticed by the family to give out a peculiar smell. Directions were given not to use any more of the water ; and the children, although very sick, recovered. I think there should be better laws with reference to securing better drainage and less filth about all our country municipalities.

Braintree. — (4,156 — 75) No fatal cases of small-pox. No cases of measles. Very few cases of scarlet-fever, none fatal. One case only known of cerebro-spinal meningitis. Although diphtheria prevailed in different parts of the town in the month of December, yet there have been four fatal cases only during the year. No whooping-cough. No erysipelas. A few sporadic cases of typhoid fever, three fatal. A few cases of cholera infantum, one case of typhoid dysentery. Pneumonia confined to no particular locality, has prevailed to a limited extent; four fatal cases.

Brewster. — (1,219 — 21.) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, or diphtheria. One fatal case of croup. Whooping-cough quite prevalent, no fatal cases. No erysipelas. About twenty cases of typhoid-fever in this vicinity : two deaths occurred in my practice. Not many cases of diarrhœal diseases. But few cases of rheumatism. Not so many cases as usual of acute pulmonary diseases.

It has been decidedly the most healthy season that I have seen since living here.

Bridgewater. — (3,969 — 57.) No small-pox. German measles are prevailing at this time, Mar. 1, 1878 (no cases of true measles during the year), amongst all classes; contracted at school invariably. Scarlatina, in a light form, has been reported in different sections of the town, and, like measles, contracted at school. No cerebro-spinal meningitis. Several cases of diphtheria reported: I have treated myself a great many cases of throat-disease, but have yet to see a case of true diphtheria. False croup prevalent in the fall and winter among children of parents unable to provide sufficient covering. No whooping-cough. Four or five cases of erysipelas accompanying wounds; none spontaneous. Only two cases of typhoid-fever to my knowledge, both in the immediate vicinity of a large open cesspool, a nuisance I have notified to be abated. Dysentery and diarrhœa were prevalent in the fall. Rheumatism is a very common disease in this region among middle-aged and aged. Pneumonia was prevalent in the fall and winter.

Brimfield. — (1,201 — 29.) No case of small-pox during the whole year. Perhaps half a dozen cases of scarlet-fever, all told; mild, and all recovered. There have been a few cases of *scarlatina simplex*, not more than six or eight: only one of the malignant form of this disease, a young man of nineteen, who died; and although the family to which he belonged is large, and composed mostly of young persons who have never had the disease, still no other case has occurred in the family, though the conditions were favorable for its spread, if the disease is really of a contagious character. The mild cases were sporadic, occurring here and there, a single case in a family. No case of meningitis during the year. Diphtheria has been more prevalent than in any previous year: in this town two fatal cases have occurred. I have seen several deaths from it in adjoining towns. Only one patient have I seen with croup; that, a year and a half old child, who died in five days: diphtheritic croup I called

it. None at all of whooping-cough. A few mild cases of erysipelas and all recovered. We have had considerable typhoid-fever; but the cases all occurred in the same locality, and were mostly confined to one house, the hotel: all have recovered. Much more of diarrhœal diseases than usual, among both adults and children. Dysentery especially has been frequent, but one death from these causes however. The past year has been remarkably free from pulmonary diseases: scarcely any thing of note in this line comes to my mind.

Brockton. — (10,578 — 198.) I do not know of a case of small-pox having occurred during 1877. Measles have been present in a very limited degree. There has been quite a run of scarlet-fever, mostly of an average or mild type, with but few cases of a severe form, or of those resulting in death. Cerebro-spinal meningitis has not been around enough to excite especial attention. Diphtheria has been very plenty and very severe, having had one very extreme epidemic during the winter and spring, with a mild and short one during the fall. Croup has been noticed to be quite frequent, especially during the diphtheria epidemics. No epidemic of whooping-cough, but a few scattered cases. A few cases only of erysipelas. Less typhoid-fever than has been seen for a number of years. Diarrhœal diseases quite frequent, and severe during the summer months, especially dysentery. But few cases of rheumatism. There were a few cases of acute pulmonary diseases noticed during the winter months; but the rest of the year has been unusually free from pneumonia and acute bronchial troubles. I have not known of any cases of acute tuberculosis.

Among all the diseases which have fallen amongst our people in Brockton, none of them has created so much dread and fear as diphtheria. It has been very severe, killing an enormous percentage of those who were subjects of any sort of a severe form of attack. I have seen it kill by pyæmia perhaps oftener than otherwise ; some by asphyxia, and a few by paralysis of the heart, even in, at first, seemingly mild cases, and often when the membranous appearances had nearly or wholly disappeared. I have seen it under all kinds of hygienic surroundings; but I think in low, damp, ill-drained portions of the town have been the seat of the bulk of the most malignant types. I think I gave the same opinion as regards this latter point to the Board of Health some months ago; and I still feel convinced, from further observation, that there is something in the condition of the soil that has an influence on the severity of this disease. To what few cases of scarlet-fever have come under my observation this past year, the same rule may be applied with equally good foundation.

Whether the widening of our streets, and the filling in of pond-holes and low, damp meadow lands, has had any thing to do with lessening the frequency of typhoid-fever in our town, I cannot positively say; but it is a fact, that, since those improvements have been made, typhoid has appeared much less frequently and in a very much milder form. The cutting away of our woodlands and draining of swamps, I believe, is another factor in the reduction of the frequency and severity of this fever. It now remains for us to have a good water-supply and a general drainage of the town.

[A feeling that the well-water of the town is not pure, and the wish to introduce pure water, have led to measures for establishing a storage-basin and a public distribution of pure water in this town. When the place was visited by the Secretary of the Board, a few specimens of the wells, thought to be about the average, were taken for examination. The results, as given by Prof. Nichols, show that all are suspicious. The town-pump, which was frequently resorted to because it was thought to to be especially good, reveals an amount of impurity which should condemn it for domestic use. The reservoir is for use in case of fire, and stores surface-water.

[Results given in parts per 100,000.]

	Ammonia.	Albuminoid Ammonia.	Inorganic.	Organic and Volatile.	Total at 212° F.	Chlorine.
Reservoir, . .	0.0061	0.0251	2.70	2.76	5.46	0.4
Town Pump, . .	0.0405	0.0085	35.3	6.80	42.10	8.2
Private well, . .	0.0035	0.0080	12.2	4.10	16.30	3.6
Private well, . .	0.0048	0.0072	19.8	5.3	25.1	4.8

[All the specimens showed evidence of the presence of nitrates.]

[All the specimens show evidence of the presence of impurity.]

Buckland. — (1,921 — 40.) No small-pox. No measles. Very few and mild cases of scarlet-fever. No cerebro-spinal meningitis. Some cases of diphtheria, not malignant. Very few cases of croup, none fatal. Great many cases of whooping-cough during the latter part of the summer and fall ; very severe, almost the entire people seeming to have it. Individuals who had it before seeming to have it as severely as those who had not. Very few cases of erysipelas, and very mild. More cases of typhoid-fever than in the last five years, but few deaths. They were not confined to one locality, but prevailed in different parts of the town. Perhaps more of the cases were in the vicinity of, and on the banks of, the Deerfield River, which was very low through the summer. Diarrhœal diseases, not as many as usual. Rheumatism, about the usual number, but none fatal. Acute pulmonary diseases : I think there has been more than the usual number; some fatal cases in old people.

With the exception of whooping-cough, which seemed to affect the great part of the people during the fall, and the cases of typhoid-fever which were mostly about that time, we have had less than our usual amount of sickness during the year.

Cambridge. — (47,838 — 1,033.) Small-pox, no cases known. Measles, not prevalent; no deaths. Scarlet-fever, comparatively mild in type; eighteen deaths. Cerebro-spinal meningitis, not prevalent; three deaths

reported. Diphtheria, apparently more prevalent than in preceding year; eighty-nine deaths reported, which include deaths by croup. I think more cases of the disease are now seen in what are fairly considered more healthy portions of the city. Whooping-cough, as usual; fifteen deaths reported. Erysipelas as usual; twelve deaths. Typhoid-fever, as usual; thirteen deaths reported. Diarrhœal diseases: one hundred and seventy-two deaths reported; sixty-six deaths of this number falling to dysentery; and thirty of these deaths by dysentery taking place in the Washington-street district of ward two. Rheumatism, as usual; five deaths reported. Acute pulmonary diseases, eighty-four deaths reported. Not unusually prevalent.

Chelsea. — (20,737 — 334.) A few cases of small-pox in mild form. Rather less of measles than in years past. Scarlet-fever not epidemic, but now and then cases occurred during the greater part of the year. Cerebro-spinal meningitis; none of this in 1877. Diphtheria has been present (not in severe form) most of the year. Rather less croup than usual. The latter part of the year whooping-cough appeared in epidemic form. A few cases of erysipelas here and there. Less of typhoid-fever, and mild in character. Less of diarrhœal diseases, so that during the summer months our city was quite healthy. About the usual amount of rheumatism. I can see no change in acute pulmonary diseases from other seasons.

Chester. — (1,396 — 23.) No small-pox. No measles. No scarlet-fever. No cerebro-spinal meningitis. No diphtheria. No croup. No whooping-cough. No erysipelas. A few cases of typhoid-fever, not over ten; none as epidemic. A few cases of diarrhœal diseases in the summer among children teething; none as an epidemic. Very little rheumatism. Only three cases of acute pulmonary diseases in 1877. The year has been one of great general health.

Chilmark. — (508 — 7.) No small-pox. No measles. No scarlet-fever. No cerebro-spinal meningitis. No diphtheria. No croup. Whooping-cough quite prevalent the latter part of the year. No erysipelas. No typhoid-fever. A few cases of diarrhœal diseases. A few cases of rheumatism. No acute pulmonary diseases.

The past year, 1877, has been unusually healthy in the towns of Chilmark, Gay Head, and West Tisbury. There have been no epidemics, with the exception of whooping-cough, which commenced in December and is still prevailing. It has been of medium severity, no deaths having occurred. Very little acute disease of any kind has prevailed.

Clinton. — (6,781 — 124.) No cases of small-pox. No cases of measles. Scattering cases of scarlet-fever, generally mild in type; only two deaths. Three deaths reported from cerebro-spinal meningitis. Three deaths reported from diphtheria. Two deaths reported from croup: one of them was diphtheria. Whooping-cough not epidemic; one death reported. A few mild cases of erysipelas, one severe. A few mild cases of typhoid-

fever; no deaths. Diarrhœal diseases quite prevalent in July, August, and September; fourteen deaths reported. Pneumonia prevailed in winter and spring; three deaths reported. There has been a good deal of sickness in town, but no one disease has been very "prevalent." No epidemic of diphtheria; but very many cases of diphtheritic sore throats, recovering in four to six days. Consumption has increased very much within a few years. Number of interments reported, twenty-four out of a hundred and twenty-seven, which is about twenty per cent. They are mostly young persons of foreign parentage, principally Irish, who are put into the mills at the youngest age allowable, and kept there without a single week's rest until they are unable to work any longer. How much the habit of "dipping snuff" has to do with predisposing to disease I cannot say: it may be an important factor. The use of snuff by young girls is almost universal among the class spoken of. I believe the factories are as well ventilated as they can be, and yet the deaths from consumption are twenty per cent as reported to the town clerk. Of course those cases reported as consumption are not all phthisis: still I think that cases of phthisis are alarmingly frequent. Something ought to be done in all our towns to compel the authorities to register the causes of death correctly. I have been asked to fill out but one blank "cause of death" during the year 1877, and I presume other physicians have had a similar experience. Twenty cases are reported as "infantile," whatever that may mean. Lead-disease, from drinking water conveyed through lead pipes, is, I think increasing, notwithstanding all that has been said and written upon the danger of such material for conveying water. One death has occurred in 1877, and one in 1876. The number of children deceased under ten years of age was sixty-two. In 1876 the number was eighty.

Colrain. — (1,699 — 22.) There has been but little sickness in town the past year. There are a few cases cf measles and whooping-cough.

Concord. — (2,676 — 40.) No small-pox. No measles. A few scattering cases of scarlet-fever, mild in character, in May and in October; no deaths or bad sequelæ. No cerebro-spinal meningitis. During the past year I have known of twelve cases of diphtheria in Concord and Bedford, where I also practise. Seven were in Concord, of which two were fatal; one, however, from co-existent Bright's disease. Of the five in Bedford, two were fatal, one from extension to trachea in a baby. Four of these were in one family, where privy was near well, and sink-drainage lay under the windows. Family were warned of the danger, but neglected it, and had two cases of typhoid in end of summer. No croup. There were a great number of cases of whooping-cough during the winter months, nearly all the children in several district schools suffering from the disease. It gradually died out, the last cases occurring in July. I have known of four cases of erysipelas: one facial; the other three of the legs or body, or both. One occurred in a child three weeks old, and lasted more than a month, shifting from place to place, and finally causing abscess in leg, with very slight injury to the child's general constitution. I had two cases of typhoid-fever in one family in Bedford, — the same in which

there were the four cases of diphtheria. Hygienic surroundings very bad; both recovered. One was in August, and one in the end of September. There were two fatal cases reported in Concord: one in March, and one in October. These cases also occurred in one family. Of diarrhœal diseases, there was remarkably little. Almost no cholera-infantum. Slight epidemic of dysentery in August in a tenement-block, with a dilapidated wooden spout to carry off sink-drainage leading through all the cellars. A good deal of slight sub-acute and muscular rheumatism and sciatica. Only three or four cases of acute rheumatism. Ordinary amount of bronchitis. Nothing else.

A remarkable fact has been the great tendency to phlegmonous inflammation.

Conway. — (1,452 — 22.) No small-pox. No measles. A few mild, sporadic cases of scarlet-fever. No cerebro-spinal meningitis. A few cases of diphtheria of very mild type. No croup. No whooping-cough. No erysipelas as an epidemic. The number of cases of typhoid-fever not so large as usual, and not severe. But a small number of cases of dysentery. The number of cases of cholera-infantum less than usual. Nothing unusual as to rheumatism. A number of cases of pneumonia, but generally yielding to treatment, and terminating favorably.

Our town has been unusually healthy during the year.

Dalton. — (1,759 — 33.) No small-pox. No measles. No scarlet-fever, I think. No cerebro-spinal meningitis. A few mild cases of diphtheria. No croup. A few cases of whooping-cough. One case of erysipelas. Three or four cases of typhoid-fever. A little of diarrhœal diseases in the summer and fall. I know of no severe cases of rheumatism. No acute pulmonary diseases, I think.

The general health of the town has been good during the past year. There has been quite a number of persons of seventy years and upwards died, but no prevailing epidemic.

Dana. — (760 — 13.) No small-pox. We have eight hundred inhabitants, and have had eight cases of measles in town. Six cases of scarlet-fever, none fatal. No cerebro-spinal meningitis. No diphtheria. Whooping-cough prevalent. But little erysipelas. No typhoid-fever. Sixteen cases of diarrhœal diseases, two fatal. Four cases of rheumatic fever.

The general health has been very good.

Danvers. — (6,024 — 102.) Small-pox has not prevailed in this town or vicinity during the past year. But little trouble has been experienced during the past year on account of measles: there have been a few mild cases, but no deaths. There have been a few cases of scarlatina, but it has not prevailed as an epidemic. There have been no cases approximating to a well-defined case of cerebro-spinal meningitis. There have been about ten deaths from diphtheria during the year. Some slight cases of croup have occurred; one or two deaths. No great increase of

whooping-cough: it has been amongst us some, and two or three have died where it became complicated with acute disease of the lungs. Erysipelas has prevailed somewhat, but only in sporadic form, and perfectly controllable. No deaths directly from its effects. Some cases of typhoid-fever; but it has not prevailed really as an *epidemic*, and it has not been confined to any particular locality, but the cases have been scattered over the whole town. I think that the troubles usually experienced in the "alimentary canal" have been very mild, and easily controlled. I know of no cases that resulted fatally, excepting a few very young children in connection with dentition. Considerable rheumatism, especially neuralgic. A number of the deaths may have partly resulted from this complicating difficulty. I do not know of even one death, the cause of which could be attributed to rheumatism alone. Acute pulmonary diseases have given more trouble during the last year than any other diseases. There has been a large percentage of deaths from diseases, simple and complicated, coming under this head. Pneumonia has played a conspicuous part, both in its simple and complex forms. In many instances it has done its fatal work while working in so latent a form that one would be at a loss in diagnosing whether to call it pneumonia, or attribute the death to some other vital lesion. Aside from purely chronic diseases causing death, old age, accident, &c., there have been more deaths from these diseases than all others, both in the young and old. I think our soil, our lack of proper drainage, unfavorable climatic influences, all tend to this result. The group of diseases which disturb us the most here in Danvers is confined to the lungs and the textures; viz., mucous, glandular, &c., most intimately connected in function or organization. These organs are more likely to take on diseases in some form or other, for the reason that they are in the front rank of exposure. There has been about the usual number of deaths from what is usually denominated pulmonary consumption, and also from tuberculosis proper. Pneumonia, in form both simple and complicated, has prevailed, terminating fatally in many cases. Bronchial catarrhs are prevalent at all seasons. Influenza seems to be invited here every spring and fall; and it seems now likely to winter with us.

Douglas. — (2,202 — 46.) Small-pox, not at all. There have been quite a number of cases of measles of mild type. Two or three cases of scarlet-fever in a mild form. No cases of cerebro-spinal meningitis. Diphtheria quite prevalent in a mild form. A few cases of croup. Whooping-cough has prevailed to some extent. A few cases of erysipelas. Not more than half a dozen cases of typhoid-fever, and those of a mild type. Diarrhœal diseases have prevailed to no great extent. A few cases of rheumatism. Acute pulmonary diseases prevailed quite extensively during the spring.

Influenza and bronchitis prevailed quite extensively during February and March. Pneumonia and rheumatism were present to some extent in April and May. The diarrhœal diseases of summer began their invasion the last of July, but subsided in a few weeks. Diphtheria has been hardly absent at any time, but usually in a mild form, with but few deaths.

It has been mostly among the foreign population, though there have been some cases among our best families.

The Douglas Axe Manufacturing Co. is in East Douglas. Many of the laborers in the axe-works, especially those who grind the axes, have, and die with, what is called "grinder's consumption." There have also been quite a number of deaths from ordinary pulmonary consumption.

Dudley. — (2,653 — 47.) Not any cases of small-pox. But few cases of measles. Not any scarlet-fever. Not any cerebro-spinal meningitis. About twenty cases of diphtheria, some of them very severe, in New Boston, a small village over in Connecticut. Not any whooping-cough. Not any erysipelas. Very few and very mild cases of typhoid-fever. But few cases of diarrhœal diseases, and remarkably mild. But little rheumatism. Acute pulmonary diseases, mild.

This town and vicinity has been very healthy the past year. No epidemic or contagious diseases. Acute diseases have been mild.

Eastham. — (639 — 13.) Not any small-pox. Not any measles. Scarlet-fever prevailed for the last six months in the mildest form I ever saw. Not any cerebro-spinal meningitis. Probably twenty cases or more of diphtheria. But few cases of croup. Not any whooping-cough. Typhoid-fever prevailed in a mild form. Diarrhœal diseases milder than usual. But few cases of rheumatism.

I had three cases of diphtheria last July in one family, all of which died, located in South Orleans on high, sandy land, thirty rods in one direction and forty in the other from tide-water, and some thirty rods to the westward of a large cranberry-bog. I am just now having, and had, six cases in one family in South Orleans; all recovered but one, which still remains in doubt: located on dry, sandy land, with forest close on one side, and swamp not far on the other side. No diphtheria in any part of Orleans but South Orleans. Not any in Eastham.

Easthampton. — (3,975 — 72.) No small-pox. No measles. Few cases of scarlet-fever, and mild; not more than five or six cases. No cerebro-spinal meningitis. Scarcely any diphtheria, and none malignant. Little croup, and no fatal cases. Had an epidemic of mild whooping-cough. No erysipelas. Very few cases of typhoid-fever: I know of but two fatal ones. Diarrhœal diseases not prevalent to any extent. Not a case of severe acute rheumatism. A few cases only of acute pulmonary diseases.

There has never been known a year of such exemption from illness among the people of this town as 1877.

Easton. — (3,898 — 47.) The health of this town during 1877 was all that could be desired. With the exception of a few cases of diphtheria early in the spring, and a few cases of mild typhoid in the fall, there were no prevailing diseases worth mentioning.

Enfield. — (1,065 — 24.) No small-pox. A case of measles came to Greenwich village school the last of November. Every child in the place

but one or two had the disease. At one time thirty-seven cases were down. No complication worthy of mention. Three mild cases of scarlet-fever in Enfield. Two severe cases of rheumatic complication in Greenwich. No cerebro-spinal meningitis. No diphtheria. No croup. First case of whooping-cough in July, extended into '78 ; all ages, from *two weeks* to eighty-five years ; no deaths. One severe case of erysipelas in January, another in March. Both facial, and both recovered. One fatal case of cholera infantum. One of dysentery, the first in Prescott. No rheumatism. Pneumonia, six fatal cases. Some twenty-five cases of congestion among children in March, April, and May.

Typhoid fever : Smith's Station, Enfield, had twelve cases in October and November, almost simultaneously, among laborers. I could find no single cause, as the conditions were not the same in all cases, except that all worked in one mill. Some of the houses were over wet cellars, and the first two cases over a cesspool. Others, Irish, were "huddled" in sleeping. One was under good sanitary conditions as far as I could ascertain, in the house, though next door to the first two cases. The whole village is damp, and the site was once a swamp. In nine cases diarrhœa was prominent; in three, exhaustion; in three, constipation; two of these cases hardly mild.

E. E. C. was bitten by a fifteen-year-old cat on left forefinger. Same cat, four days later, bit a boy severely in the calf of his leg : the boy is yet well. C., two months later, had following symptoms : Wednesday, excited, some trouble in swallowing. Thursday, same difficulty in swallowing, though not constant ; evening, raving from eight to two or later. . Next morning so that he was bound, as he had struck three individuals in his ravings. Friday, drank milk and water with no spasm, when asked by a physician, but would not try until urged a long time. Great excitement all day. Mania at midnight again. Saturday drank as easily; no laryngeal spasm; some slight hyperesthesia of skin, but not constant. No convulsions of any sort at sight or sound of water, only "aversion," but complaint of pains in chest. He finally used applications of mustard-water, himself applying the hot cloths. Mind weaker towards night, talking of death, believing there was no hope for him. Sunday grew weak rapidly, and died from asthenia at two, P.M. The case lacked most of the symptoms of hydrophobia : certainly the case at Chicopee had a far different history.

Essex. — (1,713 — 25.) No small-pox. A few cases of measles of mild form. Several cases of scarlet-fever, mild. No case of cerebro-spinal meningitis. Diphtheritic inflammation of the throat prevails in this town every year, to a greater or less extent. The present year the disease has taken on a mild form. Few cases of croup, not severe. But very few cases of whooping-cough. Erysipelas not prevalent during the year. There have been eight or ten cases of typhoid-fever during the year, and one death. Diarrhœal diseases not so prevalent as usual. Few cases of acute form of rheumatism; more of chronic. Several cases of acute pulmonary diseases during early part of year.

After a residence of some sixteen years in this town, I can recall no year within that time that has proved so healthful as the present.

Everett. — (3,651 — 70.) No case of small-pox. No case of measles. About ten or twelve cases of scarlet-fever, two fatal; patients' residence on low marsh. One fatal case of cerebro-spinal meningitis. Twenty-five cases of diphtheria; ten deaths. One case laryngeal croup; recovered. Pertussis quite prevalent; two deaths. No cases of erysipelas. No typhoid-fever. One case typhoid dysentery, fatal. Several cases of acute rheumatism. Two fatal cases of acute pulmonary diseases.

Diphtheria in this town in 1877 was not of so virulent character as in 1876. I had one case where the lying-in mother had it severely, and the infant died when two weeks old. The nurse also had the disease, and the father. and son two years old: the others recovered. I am sure that the close proximity of the water-closet vault was the sole cause. Scarlet-fever has been usually light, though attacking different members of the same family. Not very much diarrhœa, simple or inflammatory. At the present time, there are large numbers of school-children affected with parotitis. Many cases of bronchitis, mostly recovering in two or three weeks. Have urged upon my patrons the absolute necessity of cleaner vaults. Nothing more occurs to me at this date.

Fairhaven. — (2,768 — 31.) No small-pox. One case of measles; have heard of no other; disease contracted in New Bedford. About a dozen cases of scarlet-fever. No epidemic. No cerebro-spinal meningitis. Perhaps a dozen cases of diphtheria, all occurring in wet localities, with bad drainage; no deaths. No croup. No whooping-cough. A few idiopathic cases of erysipelas; not more than eight or ten. Very few cases of typhoid-fever. Very few cases of diarrhœal diseases, and those mild. A few cases of rheumatism of short duration. No heart or other serious complications. With the exception of a limited number of cases of bronchial inflammation, arising from, or complications of, influenza, these diseases have been rare. Pneumonia has seldom been observed: the few cases that have occurred have been mild.

The year 1877 has been the most healthy in the memory of the present generation. During the entire winter and spring we have influenza every year: this is no exception. This year rheumatism, neuralgia, and skin-diseases have been more frequently observed than any others. Eczema has occurred more frequently than in other years. Cases of indigestion and their complications are never absent.

Fall River. — (45,340 — 1,133.) Not any small-pox. Measles very prevalent for many months past. Nothing worthy of special notice in type. Now and then a case of scarlet-fever through fall, and yet generally mild. Have not seen or heard of a case of cerebro-spinal meningitis in this city during the year. At no time during 1877 have we been without cases of diphtheria; never very numerous, and not a large percentage of deaths. An occasional case only of croup, independent of diphtheria: the latter has been with us nearly always fatal. But little whooping-cough. Sel-

dom a year with so little erysipelas. Less typhoid-fever than for very many years. Diarrhœal diseases: nothing deserving special mention; if any thing, rather fewer than usual. The number of cases of rheumatism and acute pulmonary diseases unusually small.

Falmouth. — (2,211 — 43.) No small-pox. During the spring there were about a dozen cases of measles: it was brought into town from New Bedford. Some cases were quite severe, and left affections of the eye behind. Scarlet-fever has not occurred, so far as I know. No cerebro-spinal meningitis. Have not seen any cases of diphtheria: I do not think any have occurred, although cases (few) have been reported. Tonsilitis and ulcerated throats have been very prevalent. No croup. Whooping-cough is now prevailing in Wood's Hole: I do not know how many cases, but should think twenty. I have only known of two cases of erysipelas, — one of the fore-arm, and one facial: the first phlegmonous. The case of facial erysipelas occurred in the nurse attending the arm. Have seen only one case of typhoid-fever. Two cases of rheumatism. One case of pneumonia, fatal. Acute bronchitis and influenza have prevailed here as usual during the autumn and winter to a great extent.

Fitchburg. — (12,289 — 238.) No small-pox. No measles. Scarlet-fever has prevailed in a mild form during a part of the year; quite a number of cases occurring during January and February, and then gradually disappearing: slight cases of a sporadic character were observed during the last half. Three or four cases of cerebro-spinal meningitis have been reported; but the diagnosis in all of them could not have been considered established beyond question, and they were not marked cases. Diphtheria has prevailed to a limited extent. Most of the cases occurred in January, February, and March, gradually declining until May, since which no severe cases have occurred. Croup has been extremely rare. Whooping-cough has prevailed in a mild form to a limited extent. Erysipelas has been prevalent in a mild form, more especially during the latter months of the year. In the latter part of summer typhoid-fever was prevalent, but almost universally of a mild type; much less than usual. Diarrhœal diseases have been much fewer than usual. All the deaths from cholera-infantum were of children under one year of age. There were a few mild cases of dysentery. Rheumatism has been prevalent to about the usual extent. Cases were more numerous the early part of the year than since. Pneumonia, bronchitis, and influenza have not been as prevalent as in most former years. Nothing like an epidemic has appeared, and the cases almost universally have been of a mild and sporadic character.

The year 1877, as a whole, was a year of remarkable health in the community. It is the universal experience of physicians in this vicinity, that a year has not been passed for a long period so exempt from the prevalence of acute diseases. It has been characterized by almost the complete absence of any thing that could be termed an epidemic. No instances have occurred in this vicinity of severe cases of sickness springing from unfavorable hygienic conditions, or having a local origin; and all sections of the city appear to have been equally healthy.

Diphtheria, which was prevalent during the first three or four months of the year, seemed the continuation of a pretty severe outbreak of the disease in the spring of 1876, when many severe cases occurred, and twelve deaths were recorded in one month. In the summer and fall (1876) cases still occurred, and it was not till nearly the early part of the summer of the year past that the disease disappeared.. The distribution of the cases of this disease has been pretty uniform, and all sections of the city have been invaded.

Florida. — (572 — 8.) No small-pox. Three cases of measles. No scarlet-fever. No cerebro-spinal meningitis. Two cases of diphtheria. No croup. No whooping-cough. No erysipelas. No typhoid-fever. No diarrhœal diseases. No rheumatism. No acute pulmonary diseases.

Our town has been very free from disease the past year.

Foxborough. — (3,168 — 54.) No small-pox. No measles. Possibly a few isolated cases of scarlet-fever, mild. No cerebro-spinal meningitis. One case of diphtheria in this town, fatal. No croup within my knowledge. Whooping-cough was prevalent during the first quarter of the year. Several deaths of young children from this cause. During the prevalence of the disease, an unusual amount of sympathetic or secondary attacks among adults who had previously had the disease. A few isolated cases of erysipelas, mild. A few, probably less than twelve, cases of typhoid-fever, in the last four months of the year. Most of them mild; no deaths. Less than an average of diarrhœal diseases, confined mostly to children, and not very severe. Acute rheumatism has not been prevalent: there have been occasional cases scattered through the year. During the first part (four months) of the year, there was an epidemic of catarrhal bronchitis, called influenza: only a few cases were severe; no deaths. Several fatal cases of pneumonia in the spring, but no general prevalence of the disease.

In general, the health of the town is to be considered good during the year, as there has been no epidemic except whooping-cough. In the early spring an isolated family living in Wrentham was attacked with scarlet-fever quite severely; recovered, with sequelæ. This was thought to be a case of contagion from infected clothing worn by a visitor from Attleborough, where the disease existed. In August a child arrived in Norfolk from a Western city where diphtheria prevailed: she was thought to be well when the family left their home, and grew sick during the last day or two of travel. This proved to be a case of diphtheria, and the child died. The mother was also attacked after the child had been sick about a fortnight, but slightly, and she soon recovered. No other cases occurred in the vicinity, although there were several children of varying ages in the house.

Gardner. — (3,730 — 53.) Not a case of small-pox. No measles to my knowledge. A large number of light cases of scarlet-fever, and a few severe ones; one or two fatal. Two fatal cases of cerebro-spinal meningitis; not many others. One fatal case of diphtheria, taken at a funeral

in another town. Others of the family had more or less severe attacks. One other imported case, not severe; many sore-throats. Very little croup. Whooping-cough light and not frequent. Erysipelas not prevalent. A few cases of typhoid-fever, not severe. Much less than usual of diarrhœal diseases. More than an average number of cases of rheumatism. Acute pulmonary diseases light. Not near as much acute disease last year as usual in this town.

Georgetown. — (2,214 — 39.) No small-pox. Measles not very prevalent. Mumps have been epidemic during the earlier part of the year. Scarlet-fever sporadic, of mild type: children of families in which this disease exists are excluded from school until desquamation is gone through with, and the houses disinfected with sulphurous acid, generated in the presence of steam to make it more effectual. No cerebro-spinal meningitis; none for the last year. Diphtheria epidemic in the neighboring town of Groveland; seldom seen in this town; when present, generally of mild type, and the worst cases were imported. Same rules to prevent the spreading of this are used as in scarlatina. Croup prevalent to a considerable extent in the first part of the year; no fatal cases. One case of typhoid-fever of mild type. We have been remarkably free from acute pulmonary diseases. The prevailing lung-troubles are chiefly of a phthisical nature.

The condition of this town for the last twelve months may be considered as one of extreme health, as may be inferred from the previous pages. There seems to have been no epidemic of any sort; and the general business has been looking after chronic cases and confinements. The only case of real merit comes up under the heading erysipelas, — dry gangrene in a young man aged thirty-five, of unexceptionable habits, resulting from a simple prick from a splinter of pine wood. This necessitated amputation of the finger, then of the arm at the shoulder, death resulting from the extension of the disease.

Gloucester. — (16,754 — 400.) No case of small-pox that I am aware of. Measles quite prevalent in the latter part of spring and in the early summer; generally mild, and no deaths that I am aware of. Scarlet-fever has prevailed extensively, more probably during the early part of the year; but at no time have we been without cases in our city. No cerebro-spinal meningitis that I know of. The same remarks made regarding scarlet-fever will apply to diphtheria, as regards the time when it has most prevailed, though of the two diseases the latter has been probably much more prevalent. I have known of no cases of croup, excepting such as have followed or accompanied diphtheria. My *impression* is that the proportion of these, as compared with former years, has been large. Have seen no case of whooping-cough professionally, and am led to believe that there has been no special prevalence of the disease. Very little erysipelas, so far as I can learn. I have never known of its being very prevalent here. There was an unusually large number of cases of typhoid-fever during the latter part of the summer and in the autumn, some very severe and fatal; but the general type of the disease was mild.

I am not aware that the average of diarrhœal diseases has varied much from that of former years, though perhaps during the summer it may have been somewhat higher. Rheumatism not above the average probably. Little variation from former years in acute pulmonary diseases, so far as I am aware.

Granby. — (812 — 23.) No cases of small-pox. Measles were epidemic last spring through all our schools; no fatal cases. No cases of scarlet-fever. No cases of cerebro-spinal meningitis. Two or three mild cases of diphtheria. Several cases of spasmodic croup; no cases membraneous. Whooping-cough epidemic through the summer; went through the town; no fatal cases. Three mild cases of erysipelas. Two mild cases of typhoid-fever. Nothing unusual as to diarrhœal diseases; one death. Nothing unusual as to rheumatism; no severe cases. Acute pulmonary diseases less than other years; two fatal.

This has been a year of good health. It is a fact that we have less sickness each year, better sanitary regulations, more general knowledge of the cause of disease, consequently more intelligent measures taken to prevent it.

Granville. — (1,240 — 33.) No small-pox. No measles. No scarlet-fever. No cerebro-spinal meningitis. There has been diphtheria in this town to some extent the past year. It was of the asthenic form; the deposit upon the throat was of a soft, pulpy kind; also great swelling about the neck; prostration was great, and began early. Four persons died in two weeks' time in one family, aged respectively nine years, seven years, three years, and two years. No more deaths occurred. There were many cases of a very mild form; exudations on the throat were whitish and also grayish color, temperature ran high; but in every case recovery was rapid and complete. No croup. No whooping-cough. There have been quite a number of cases of simple or cutaneous erysipelas in my practice; one case where the scalp, face, and neck were involved, and also abscess of the external auditory tube; quite a serious case (patient apparently recovered). There have been cases of typhoid-fever during the months of October and November, two of which died. (I am myself just convalescing from that disease; very nervous.) Those cases that ended fatally, died from perforation of intestine. Have been a large number of cases of diarrhœal disease during the past year, one case ending fatally, aged eight and a half years, with bloody flux; one case of enteritis accompanied by diarrhœa, ending fatally, age, fifty-seven; three cases of phthisis, in which diarrhœa probably aided in bringing about the fatal result, and many other cases which I have been called to treat, the cause being from the combined action of exposure to changes of temperature, foul air, and errors of diet. Four or five cases of articular rheumatism, one of which died, Feb. 10, aged twenty-three, complicated with meningitis and chorea. Rheumatic disorders are quite rife in this locality during latter part of the fall, also winter and spring, probably caused by sudden changes of temperature, and exposure to cold and wet, and hereditary predisposition. There have been in our town for the

past year some acute pulmonary diseases. Every year we have from five to ten cases of pneumonia, besides many cases of bronchial catarrh; some of these occurring in epidemic form, sometimes called influenza. These cases occur during the winter and spring. Within the past year five have died from phthisis. Some of these cases, after having bronchial-catarrh or pneumonia, have died within two or three months; others have lingered as many years.

Those cases of diphtheria, in which four from one family died, lived in an isolated part of the town, no neighbors near by; but every person going to that house had the disease in a mild form. The house in which these fatal cases occurred was situated in a damp place, and the sanitary condition around the house was very bad. Diphtheria is not a frequent disease in our town. I do not believe tonsilitis with ulcerated patches to be diphtheria, yet the cases cited above were diphtheria. As to typhoid-fever, that is not a frequent disease in this town; but for some reason it visited us last fall. I believe local causes to be a factor of disease. There is a form of fever which occurs every year the latter part of summer and fall, which I call bilious remittent fever. In the winter and spring months pneumonia, and especially bronchial affections, are quite rife in our town, also rheumatic diseases. The town of Granville will report more deaths this year than any year previous for some time.

Great Barrington. — (4,385 — 81.) Have not known of a case of small-pox during the past year. A few cases of mild form of measles. Scarlet-fever in different parts of the town has broken out from time to time, but has generally proved of a mild type during the past year. I have not known a well-marked case of cerebro-spinal meningitis during the year. A few cases of diphtheria have been reported in town, but they were of a mild form; no deaths that I am aware of. Cases of croup have been reported about town, but I am inclined to think them very mild. But very few cases of whooping-cough. No cases of erysipelas that I am aware of. Perhaps a dozen cases of typhoid-fever. During the summer and fall quite a large number of cases of diarrhœal diseases occurred: a few proved fatal. Always more or less rheumatism at different seasons of the year. A few cases of pneumonia have occurred, but they were generally of a mild type.

Great Barrington is peculiarly and well situated to be exempt from certain diseases which owe their origin to location. The Housatonic River flows very rapidly as it passes through this region; and the town is about eight hundred feet above, and eighty miles from tide-water. It is protected from north and east winds by mountains. The people generally are intelligent; and I am fully persuaded that they are considerably indebted for their recent exemption from some diseases to sanitary measures.

Groton. — (1,908 — 28.) No small-pox. No measles. But very few cases of scarlet-fever, and those of the mildest type. No cerebro-spinal meningitis. Perhaps twelve or fifteen pretty severe cases of diphtheria and several milder cases. Has not been so malignant as the year before.

I think but two cases fatal, both children, — one Irish, one American. The cases were scattered, both in regard to time and location. Most of the cases were in some of our best families. Only a few mild cases of croup. No whooping-cough, I think. Not more than three or four cases of erysipelas; none fatal. I think but two cases of typhoid-fever. Four or five cases of dysentery, and a few of diarrhœa. Very few cases of rheumatism, perhaps three or four. But three or four cases of acute pulmonary diseases.

We have been very free from severe acute sickness in any form the past year.

Groveland. — (2,084 — 42.) No small-pox. Some slight sporadic cases of measles; no epidemic. No scarlet-fever. No cerebro-spinal meningitis. Diphtheria somewhat prevalent for two months past. A few sporadic cases of croup. Whooping-cough quite prevalent in March, April, and May, in South Groveland. No erysipelas. A few light cases of typhoid-fever. A few sporadic cases of diarrhœal diseases, wonderfully manageable so far as children were concerned, last summer. A few cases only of rheumatism. A few cases only of acute pulmonary diseases.

There have been some thirty cases of diphtheria in a population of 2,200. They have occurred in all parts of the town, without regard to locality. There have been six fatal cases that I know of: may have been one or two more in the outskirts of the town that did not come to my knowledge. I lost four cases in my own practice, three in one family where six were attacked. The hygienic surroundings where the fatal cases occurred were good. I had three cases in a house which was no better than a barn, with the wind blowing through it in every direction. The house was filthy, with a swamp on the east side, and a long reach of low meadow-land on the west. The three children, five to eleven years old, made good recoveries in from eight to twelve days, with no sequelæ so far as heard from, after a month. These three cases for the first three days looked quite as dangerous as the fatal ones. I do not know whether to ascribe their salvation to the extra free ventilation or the dirt. I take no credit for it.

Hadley. — (2,125 — 29.) There have been no cases of small-pox, measles, scarlet-fever, or cerebro-spinal meningitis. A few mild, isolated cases of diphtheria. No croup. No whooping-cough. No erysipelas. A few severe and a few mild cases of typhoid-fever. In two families, in which there were in each two cases, I have reason to suppose that sink-water percolating into the wells was the origin of the disease. Very few cases of diarrhœal diseases, and slight in character. One or two cases of inflammatory rheumatism, not severe. A good deal of muscular rheumatism, and a few cases of sub-acute disease. Considerable neuralgia. A few cases of croupous and catarrhal pneumonia, not fatal. Considerable bronchial disease, not very severe, or serious in results.

The year has been a very healthy one in this locality. In a practice of more than thirty years in this town, I have known nothing to compare

with it. The last several years have given but little sickness ; the last year has given less. There are, undoubtedly, general reasons why it should be healthy, but I am satisfied that a considerable share of the immunity is due to a better knowledge of sanitary laws. There is a much more general appreciation of the necessity of isolation in cases of diphtheria and other contagious diseases, and also a necessity to look after the sanitary surroundings. If the individuals especially interested are not cognizant of these, the people in their neighborhoods compel them to exercise care. Public opinion has shown its power very decidedly in these matters.

Hancock. — (730. — 9.) None of the diseases named in this circular have prevailed to any extent during the year 1877.

Hanover. — (1,801 — 39.) Several mild cases of scarlet-fever during the year, nothing approaching an epidemic. About fifty cases of diphtheria; eight deaths. Five were isolated cases, two fatal; see "remarks." Whooping-cough became epidemic in July, and prevailed to some extent for three months. Many adults were affected with a similar cough at the same time. Three cases of typhoid-fever : two were quite severe, running from twenty to twenty-five days; recovery complete. A few very mild cases of diarrhœal diseases during the late summer and early autumn, affecting adults as often as children. Chronic rheumatism very prevalent. Several cases of acute sciatica : two cases, one very severe, one severe but quite brief. Bronchitis has prevailed to a greater extent than usual, but in a mild form. Do not think there has been a case of pneumonia.

The general health of this community has been remarkably good for several years, and exceptionally so during the last year, in all parts of the town where there has been no diphtheria. This disease appeared in September, at the north end of a road called "Whiting Street," which extends north and south through the town, along the western border, having a large extent of low, swampy, undrained land upon both sides ; and proceeded along the road southward, visiting every house (occupied by foreign laborers) where there were children, and several families living upon two cross-roads which run eastward from "Whiting Street" across the low, wet land, and attacking with more or less malignancy forty persons, mostly children under thirteen years of age, of whom six died. This part of the town is contiguous to Rockland, where diphtheria and scarlatina are often epidemic among a numerous foreign population; and those houses visited in Hanover were, in some cases, recently built upon unprepared land, and, in almost every case, were occupied by persons working and visiting in Rockland. Of course, hygienic precautions were disregarded. The five isolated cases mentioned occurred in November, in the central and easterly part of the town, while the disease was epidemic in Pembroke, near by. I did not see the fatal cases, but they were described as being very malignant. About half of all the cases have been followed by paralysis, and all but one recovered. The whooping-cough was of a mild type among children, but peculiar from the fact that mid-

dle-aged and old persons who were exposed by remaining for a short time in the room with the young patients were almost sure to be attacked in ten or twelve days, by a cough in every respect similar, and which they transmitted to other adults in the same manner; and in many cases this cough was very much more severe than the real disease among the children. Indeed, in several cases, where old and weak persons were affected, the symptoms were grave and alarming. The duration among both children and adults averaged about six weeks. Typhoid-fever is a disease that I have seen but seldom during fourteen years' practice in this town. I find by my notes that the three cases which occurred in 1877 present more than an average degree of severity, and double the average duration. I have not seen, in my own practice, more than four cases in any one year in this town.

Hanson. — (1,265 — 17.) No small-pox. No measles. About twelve cases of scarlet-fever, none fatal or serious. No cerebro-spinal meningitis. Some few cases of diphtheria but none serious. We have had much for two years past, but it is gradually dying out. No true croup, some spasmodic. No whooping-cough. No erysipelas. A few cases of typhoid-fever, none fatal. Not one case of diarrhœal diseases where there would be fifty usually. Can't account for the few cases. Not much rheumatism. Rather more of acute pulmonary diseases than usual, yet not usually fatal; many left with a cough.

Unusually healthy this year past. The lack of cholera-infantum and similar diseases was very remarkable. Can't account for it. About the same over the entire county. Think meteorological influences have much to do with it.

Haverhill. — (14,628 — 316.) No cases of small-pox. No extensive epidemic of measles. A few sporadic cases of scarlet-fever of the anginosa type. No cases of cerebro-spinal meningitis. Spasmodic croup very common; diphtheritic croup frequent in worse forms of diphtheria. Whooping-cough epidemic last winter and spring among school-children. No epidemic of erysipelas; frequent cases among the poorer and ill-fed classes. Signal exemption from typhoid-fever last fall; some severe cases, but not wide-spread. Dysentery prevailed to some extent in the autumnal months, assumed a typhoid character. Inflammatory rheumatism is quite common with us, attacking those who handle wet leather. Pneumonia is our worst enemy. We have it every winter more or less. The last year it has assumed a typhoid type, modified by pleuritic affections.

Diphtheria has continued to prevail in Haverhill and vicinity during the entire year. No season is exempt from its attacks. We have had, upon a rough estimate, five hundred cases, with a large percentage of mortality. In several instances whole families of children were swept away by its ravages. Locality seems to have but little to do with its existence; for the highest and driest neighborhoods have been visited, while low and filthy localities have escaped. Some of our newest and finest dwellings have been invaded, where all the "trappings" of modern drainage and plumbing were introduced. A room in our new high-

school building, occupied temporarily by a primary school, has been invaded, and a large number of the children have been stricken down with the disease, with a mortality of fifty per cent. The room is directly over the urinals and water-closets of the boys. No odor can be detected, and plumbing is pronounced "perfect." Many fatal cases show signs of croup in last stages.

Haverhill is favorably located for drainage, and we have good sewers in some of the principal streets. Most of our best private dwellings, and many of the best tenement-houses, are provided with water-closets. How much these appliances have to do in introducing the disease into such houses, remains to be developed. Pulmonary phthisis is our most steady foe; and the mortality from this cause, both in spring and fall, is very considerable. With these exceptions, Haverhill may be ranked as healthy, and especially exempt from diseases of epidemic character.

Hawley. — (588 — 11.) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, diphtheria, croup, whooping-cough, erysipelas, typhoid-fever, nor diarrhœal diseases. A few cases of rheumatism, and few cases of acute pulmonary diseases.

The general health of Hawley, the past year, has been remarkably good. No contagious diseases have been prevalent. There are some cases which are called rheumatism, which in most instances, I think, are traceable to the use of water running through lead pipes. There are a few cases of pulmonary diseases, which, I think, are traceable to a hereditary cause in the families where they occur.

Hingham. — (4,654 — 89.) No cases of small-pox. Measles have not prevailed to any extent. There has been more or less scarlet-fever throughout the year; but the cases have been, as a rule, mild. No cases of cerebro-spinal meningitis. During the early part of the year diphtheria prevailed, disappearing during summer, and again appearing as the cold weather returned; cases not as severe as in 1876. Croup not prevalent. A good deal of whooping-cough, particularly in the schools. Erysipelas not prevalent. Typhoid-fever less than usual. With exception of infants, very little diarrhœal diseases. A few cases of rheumatism. Acute pulmonary diseases not prevalent.

Scarlatina and diphtheria have prevailed together. Last year (1876) there was much severe diphtheria, the mortality was high: this year there have been about as many cases, but a very few deaths. Whooping-cough has been more prevalent than any other disease. Children having it have continued attendance at school, and the disease has thus been generally distributed: the cases have been of average severity and duration. On the whole, I should say it had been a year of general health.

Holyoke. — (16,260 — 324.) Nine cases of small-pox; six recovered, three fatal. A few cases of measles in December, — exact number not known; not epidemic. Scarlet-fever has prevailed to a very limited extent. There have been a few fatal cases, not epidemic, and of a mild type. Think there has not been a clearly-defined case of cerebro-spinal

meningitis during the year. The city has hardly been free from diphtheria during the year. In the months of November and December it might be termed epidemic. There were many fatal cases; exact number not known. There have been a few cases of croup. So far as I can learn, all have been fatal; but, as none came under my observation, I report on "hearsay." Whooping-cough made its appearance in December, and bids fair to become epidemic. There have been a limited number of cases of erysipelas. All that I have seen or heard from have recovered. The city has been exempt from typhoid-fever to an unusual degree: with a population of nearly twenty thousand, there have been probably less than two dozen cases; very few fatal. Never before so few cases of diarrhœal diseases. Aside from the old chronic cases of rheumatism, I do not know, nor have I heard, nor can I learn, of a single case. In the early months of 1877, "pneumonia of young persons" prevailed to an unusual degree. Amongst my own clients, there were eleven cases: all recovered. Others met with it in a large number of cases; am unable to give exact number. It was not met with (pneumonia) in the same ratio in adults.

In my opinion, the general health of our city has been far above that of any previous year since the State Board of Health has been in existence. This is, undoubtedly, due largely to natural causes: the absence of extreme cold or excessive heat; an atmosphere neither preternaturally dry nor laden with superabundant moisture; and, perhaps, in no small degree to enforced habits of temperance in eating and drinking consequent upon a "stringent financial condition." In the frequency of diphtheria we have had the nearest approach to an epidemic. And, while it has been met with in all parts of our city, it has been most prevalent in the highest, driest, and best-drained sections.

Hudson. — (3,493 — 54.) No small-pox. Measles quite extensively prevalent. Scarlet-fever has prevailed moderately during the whole year; has been light, and but two or three deaths. Have been perhaps half a dozen cases of cerebro-spinal meningitis, and two or three deaths. One fatal case of diphtheria, and quite a number of moderate severity. Have been two deaths from membraneous croup, and two others which were diagnosticated as such. No whooping-cough of any account. Erysipelas not very prevalent; have been a few severe cases. Have been perhaps twenty-five or thirty cases, and six or seven deaths from typhoid-fever. Diarrhœal diseases not prevalent. Rheumatism more than usually prevalent. Acute pulmonary diseases not extensively prevalent.

The general health of this community has been unusually good during the past year. Pulmonary diseases especially have been unusually rare during the past four years. Diphtheria has never prevailed here extensively, and I know of but two deaths from it in the past eight years. Scarlet-fever has been of a very mild type during the past year.

Hull. — (316 — 4.) No cases of small-pox, measles, scarlet-fever, or cerebro-spinal meningitis, that I know of. Three cases of diphtheria in one family; one died. No croup, whooping-cough, erysipelas, typhoid-fever, diarrhœal diseases, rheumatism, nor acute pulmonary diseases.

The health of our community for the past year has been very good. There has been but one death in the town, as far as I can learn.

Huntington. — (1,095 — 24.) Two cases of varioloid, neither fatal; disease contracted in paper-mill. Do not know that measles have prevailed. A mild epidemic of scarlet-fever in November and December; no fatal cases. No cerebro-spinal meningitis. A few isolated cases of diphtheria; three deaths. Every case the evident result of filth. Three fatal cases of membraneous croup. Isolated cases of whooping-cough during the year. No erysipelas. No epidemic of typhoid-fever; a case here and there from bad water. Very few cases of diarrhœal diseases; less than usual. No rheumatism of any account. Pneumonia prevailed to a limited extent last March and April.

The town has been remarkably free from epidemics during the year. The prevalence of scarlet-fever is noted above. The stringency of the times, making short hours of labor in our manufactories, has been for the health of the employés by giving them more time in the open air. The sickness among the farming part of our community has been about as usual.

Hyde Park. — (6,316 — 88.) It is believed that no case of small-pox has occurred. Some cases of measles have been reported; all mild in type, without sequelæ. Scarlet-fever has not prevailed as an epidemic. Sporadic cases have not been severe. No instance known of cerebro-spinal meningitis. Diphtheria has prevailed to some extent, but not with the same severity, nor as extensively, as in some former years. Croup has occurred in some instances, but has generally had a favorable termination. Whooping-cough has not been severe. The cases that have occurred have rarely applied for treatment. Sporadic cases only of erysipelas have occurred; not in great number or severity, and have yielded to treatment. Less typhoid-fever than in any previous year for several years. Diarrhœal diseases not especially severe. Rheumatism is seldom absent in any season from our community, but has not been severer than usual. Acute pulmonary diseases have presented no unusual variation from the common course, nor been attended with a marked fatality.

The year, taken as a whole, has not been marked by an unusual amount of disease of any description. Our community has been somewhat more than commonly exempt from epidemic diseases and from the severer types of disease in any form.

Kingston. —(1,569 — 27.) No small-pox. No measles. One case of scarlet-fever, imported; child visiting here from Roxbury. No cerebro-spinal meningitis. There has been quite a number of cases of diphtheria, generally of a mild form; no death. Very few cases of croup; one death; all the other cases mild. Very little whooping-cough. Several cases of erysipelas; one death. Two cases of typhoid-fever. First case contracted at the Centennial; female. A younger sister came down with the disease; both cases severe; recovering. Diarrhœal diseases slight.

But few cases of acute rheumatism. Acute pulmonary diseases quite prevalent during the winter and spring, mostly bronchial or influenza.

There was more sickness the first half of the year. The last half has been remarkably healthy.

Lancaster. — (1,957 — 31.) No epidemic the past year.

Lawrence. — (34,916 — 872.) No well-authenticated case of small-pox has occurred during the year, that I am aware of. Measles quite prevalent during the early, and to some extent during the closing months of the year. During the first part of the year, the type was unusually severe, — thirteen deaths reported, and all in the first six months. Very little scarlatina, and only three deaths, which occurred in January and March. Two or three deaths reported from cerebro-spinal meningitis. Have no knowledge of any other cases. Croup quite prevalent in the early months, and to a less extent in the later. Eighteen deaths, or two per cent of the entire mortality. Whooping-cough has prevailed quite extensively. Seventeen deaths, mostly of infants of but a few months of age. But few cases of erysipelas during the year. Typhoid-fever not unusually prevalent, and of a mild type; only eighteen deaths reported. About an average amount of diarrhœal diseases, I judge; less than in some years; the whole number of deaths reported, one hundred and thirty-two, which includes some reported as deaths from "teething," but does *not* include about thirty deaths recorded as "infantile," — fifteen per cent of the whole mortality. Not much rheumatism. Sixty-three deaths, or a little over seven per cent, from acute pulmonary diseases. Pneumonia of the typhoid form has had the largest number of victims. The character and condition of a large portion of our population favor this form of disease in the cold months. Phthisis has caused the largest number of deaths of any one disease, — eighteen per cent, or one hundred and fifty-five deaths, distributed throughout the entire year, the larger number having occurred in the latter part of spring and early part of summer.

The registration of deaths in this city is not wholly satisfactory, chiefly for two reasons; viz., 1st, All the undertakers do not habitually procure certificates of death from the attending physicians, while, in some cases, death occurs when no physician has been called; and, 2d, There is no uniform, authorized system of nomenclature of diseases in veritable form for easy reference. In regard to the first cause, the difficulty might be obviated if the city clerk were *required* to decline all certificates of death that are not made out and signed by the attending physicians. In those cases in which no physician has been in attendance, it might be made obligatory upon the undertakers to report such cases to the city physician, whose duty it should be to investigate the facts, and make out the diagnosis in accordance with the best information he can obtain by careful inquiry. In relation to the second cause, the record of the causes of death might be made more accurate and uniform if there were kept in every physician's office a schedule of diseases having an authorized system of nomenclature. It would facilitate the proper registration of the

causes of death if the State Board of Health were to prepare such a schedule, procure for it the sanction of legislative authority if necessary, and distribute copies of it to the physicians throughout the State.

Diphtheria has prevailed to an unusual extent during the entire year. For the past three years it has been almost continually present with us; but it was not until the autumnal months of 1876 that it began to assume any serious proportions as an epidemic. The number of deaths from this cause was, in 1875, fourteen; in 1876, fifty; in 1877, one hundred and seventeen; thus showing that the disease has steadily increased. The total mortality of the past year from all causes was 875. Thirteen per cent was due to diphtheria, outranking in fatality all other diseases except phthisis. The number of deaths monthly from this cause were as follows: —

January, ten; February, thirteen; March, seventeen; April, eleven; May, five; June, three; July, eleven; August, nine; September, eleven; October, ten; November, ten; December, seven: total, one hundred and seventeen.

Nearly all the deaths were of children between two and ten years of age. As usual, the larger number of deaths were of the children of foreign parentage; there being of this class seventy-five per cent to twenty-five per cent of native-born children.

No facts have come to my knowledge which tend to throw any additional light upon the causation of the disease, or which suggest a sufficient reason for its greater prevalence in the past year than in the two preceding years.

A comparison of the atmospheric conditions of the past three years, which, through the kindness of John Fallon, Esq., Agent of the Pacific Mills in this city, I have been able to make, while it affords in some respects only negative results, may not prove to be wholly without interest or practical good. Even negative results are sometimes useful, by enabling us to eliminate suspected influences. Comparing the mean temperature of the three years, found by dividing the sum of the monthly averages (from three daily observations) by twelve, there appears to be no marked difference between the years 1877 and 1876, though a somewhat greater one between these years and 1875. In 1875, the mean temperature was 43.60° Fahr.; in 1876, 47.50°; and in 1877, 47.25°.

The average temperature of the months of January and December, 1877, was 19° for each; colder than any other two months since the disease became epidemic; but the mortality was not equal to that of many other months.

In the month of December, 1876, the average temperature was 27°, and the mortality was seventeen. In December, 1877, the average temperature was 19°, and the mortality but seven.

Many other facts of a similar nature might be mentioned, all of which go to prove, that, although the colder seasons are more fruitful of the disease than the warmer, yet the single element of a low temperature has not, in itself alone, a necessarily unfavorable influence upon the prevalence and mortality of the disease.

The influence of an excess of humidity of the atmosphere upon the

disease, although not manifest in the warmer months, is somewhat striking when associated with a low temperature. The hygrometer indicated a greater amount of atmospheric moisture in the first three months of 1875 than in any other months of that year, or, indeed of three years. The amount of the disease was greater in those months than in any other three months of that year, although by no means equal to that of three consecutive months in the latter part of 1876, or any part of 1877; but it must be recollected that the disease was not epidemic until the last three months of 1876; and therefore no comparison can properly be made between the number of cases occurring sporadically and those occurring during the presence of an epidemic influence.

Comparing the months of November and December, 1876, and January and March, 1877, when the disease was in full tide, with any other four months, and we find a greater amount of disease, and a greater aggregate of mortality, in the former than in the latter; and we find, also, the amount of the humidity of the atmosphere during those four months exceeding that of any other month since the disease had become epidemic. It is a curious fact, however, that the humidity of the atmosphere in the intervening month of February, 1877, was exceptionally low, while the mortality continued to be larger; which may possibly be explained by attributing such a result, in part, to the influence of the previous month, whose effects were in some degree manifested in the following month. I think there can be no doubt, that, when the atmosphere is charged with the "germs" of the disease in sufficient intensity to cause it to prevail in an epidemic form, its extent and mortality will bear a close relation to the degree of atmospheric humidity when associated with a low temperature. In connection with the subject of humidity, that of the number of rainy days and the amount of rain-fall may be presumed to have some interest. It may be stated, as a general rule, though subject to some exceptions, that the greater the number of rainy days, and the larger the amount of rain-fall, in the colder months, during the prevalence of the disease epidemically, the greater is the predisposition to the disease, and the larger the mortality. This is confirmed by an examination of the record of the rainy days, and the amount of rain-fall in the cold months of the latter part of the year 1876 and of the earlier and later months of 1877. In the warm months these conditions do not appear to exert any unfavorable influence. Only negative results are furnished by an examination of the barometrical variations.

The above statements are not made because they are supposed to contain any novel or surprising facts, but simply as illustrating with some force the theory that the ebb and flow of an epidemic of diphtheria are, to some extent, modified by certain conditions of the atmosphere, and unaffected by others, and as an attempt to determine what those precise conditions are.

Lee. — (3,900 — 90.) No small-pox. No measles. Only sporadic cases of scarlet-fever. No cerebro-spinal meningitis. Diphtheria epidemic only in one part of town during the year, and was attributable to bad surroundings, such as wet cellars, and heavy, wet soil. No croup. No

whooping-cough. No erysipelas. Typhoid-fever has not been epidemic: have had a few isolated cases. Diarrhœal diseases not severe. Rheumatism prevailed moderately, not as an epidemic. Acute pulmonary diseases as usual during the winter and spring.

The health of the town during the past year has been unusually good. No epidemic has occurred, except of diphtheria in a remote district where there were a few fatal cases. In the same houses a very fatal epidemic of diphtheria occurred four years ago. The only striking peculiarity of the location is that it is damp; water in the cellars during the wet season, and a soil that holds water for a long time; the whole district filled with springs of water. There is, without doubt, less of typhoid-fever, and perhaps other epidemics, in town from the fact that more preventive means are used than formerly.

Lenox. — (1,845 — 21.) No small-pox. No measles. No scarlet-fever since autumn of 1876. No cerebro-spinal meningitis. One case of diphtheria, fatal, in December (not in my practice). No croup. One case of whooping-cough, imported from New York. Two cases of erysipelas, idiopathic. One mild case of typhoid-fever in a child. Diarrhœal diseases rather prevalent in summer, but mild in form. Three cases of rheumatism. One fatal case of congestion of lungs. Several cases of acute bronchitis.

I take the above cases from my own practice, except the case of diphtheria. In the immediate village, there have been reported, I think, only one case of pneumonia and one of typhoid-fever, the latter not originating in Lenox, in the practice of others. The case of diphtheria occurred in a family of the better class, living a mile from the village, and much nearer Lenox Furnace and the Housatonic River. During the autumn I saw a number of cases of sore throat, but no diphtheria. The health of the town generally has been very good during the year; and I think, had I the time to devote to the tombstone records in our churchyard, the report would be as favorable as that of Dr. Holmes in regard to the village of Beverly Farms. The fact that a pretty large number of surgical and obstetric cases have almost invariably done well argues favorably for our sanitary condition, although the condition is not yet perfect.

Leominster. — (5,201 — 86.) No small-pox. One case of measles. Scarlet-fever, sixty-five cases, none fatal. Of course the type of the disease was mild, yet well marked; very little troublesome sequelæ. It is unusual with us to have so many cases of scarlatina without any fatality: generally about five per cent are fatal. Two cases of cerebro-spinal meningitis, neither fatal. Fifty-six cases of diphtheria; four of them fatal, — two of them dying of diphtheritic croup, one of exhaustion, one of gangrene and septic poison. Twenty-six cases of croup; one (membraneous) fatal; the others (spasmodic) recovered. Twenty-four cases of whooping-cough, one fatal. Eleven cases of erysipelas, none fatal. Fifteen cases of typhoid-fever, none fatal. For the last three or four years, since the introduction of water from the Monoosnock Hills, there has been much less typhoid than formerly. Seventy-five cases of diarrhœal dis-

eases; seven fatal; three of these cholera infantum, three of infantile diarrhœa, and one of chronic diarrhœa. Seventeen cases of rheumatism; none fatal. Fifty-five cases of acute pulmonary diseases; six fatal from pneumonia. The other cases were acute bronchitis, but not fatal.

Of course the preceding statistics must not be taken as absolutely correct, but as nearly so as our recollection can warrant. The year 1877 has been a healthy one comparatively. We have had no destructive epidemic. During the summer and fall, bowel complaints and typhoid were much less prevalent than usual. The cases of scarlet-fever and diphtheria were mostly of a mild character, and scattered along through the year. In the north-eastern part of the town, elevated and hilly, among a farming population, there were sixteen cases of diphtheria in five families. Of these, two cases were fatal by diphtheritic croup. The water-supply of these families was from old wells, being out of the reach of the town water-works. In fact, a great majority of the cases of diphtheria were in families not supplied with water from the street. On the contrary, scarlet-fever seemed to prevail as much among families supplied with water from the Monoosnock Hills as in those beyond the reach of our water-works.

Acute bronchitis (influenza) has prevailed a good deal through the autumn and early winter. The epidemic was rather severe and obstinate, with much bilious derangement, and from which recovery has been slow.

There have also been very many cases of neuralgia, connected with a torpid state of the liver and derangement of the stomach, during the same period.

Leverett. — (831 —.9.) No cases of small-pox. I have not known a case in this town for twenty years. Five or six cases of measles. Four cases of scarlet-fever, all in two families living near each other: three cases in one family, and one in the other, the last taken by contagion. No cases of cerebro-spinal meningitis. Half a dozen mild cases of diphtheria, which seemed to come from taking cold. Two cases of croup, following exposure to cold in small children. Whooping-cough prevalent in a number of families, twenty-five or thirty cases in all perhaps. Two quite severe cases of erysipelas. Not more than four or five cases of typhoid-fever. In one family three cases came from exposure to a foul sink-drain. They had the drain covered and purified. Very few and slight cases of diarrhœal diseases. A few very mild cases of rheumatism of short duration; alkaline treatment. Common catarrh quite prevalent at times, but mild and of short duration. I have one of incipient phthisis.

It has been a general remark that this has been an uncommonly healthy year. Doctors have been idle much of the time. I have never known so little typhoid-fever for thirty-four years, nor so little of any disease. No cases of pulmonary consumption, but few of dysentery; no cholera infantum, — not a case. I think the dry season had much to do with this condition of general health. But little decay and fermentation of dead vegetation, consequently but little generation of miasmatic disease. At this present writing there is hardly a sick person in town.

Lexington. — (2,505 — 46.) Not a case of small-pox in town for several years. Not a case of measles during 1877. A few years since it was epidemic here. I do not recall a case of scarlet-fever during 1877. No cerebro-spinal meningitis. Several cases of diphtheria; one at least was attended with aphonia in fifth week, and fatal from debility. The disease has not been very prevalent nor very malignant. Not a case of croup. No whooping-cough. No erysipelas. Two cases of typhoid-fever in April (out of season), and none since. Dysentery not prevalent, but several cases of severe type, one fatal, and some others mild. But two cases of cholera infantum came under my treatment; never so little before. Never so little diarrhœal disease. Only a few cases of rheumatism, not particularly noticeable. Some cases of acute pulmonary diseases, but less, very much less, than usual. The year 1877 has been very remarkable for its lack of sickness in this vicinity. During the thirty years of my practice nothing like it has occurred.

Lincoln. — (834 — 4.) No small-pox. No measles. Few cases of scarlet-fever, and all mild. No cerebro-spinal meningitis. No diphtheria. I never have had many cases, and but very few fatal ones. No fatal case of croup. Whooping-cough light, no fatal case. But few cases of erysipelas. No serious case of typhoid-fever. Diarrhœal diseases, generally from teething. A few cases of dysentery, but mild; no fatal cases. Not any cases of rheumatic-fever. Some local rheumatism, and one case sciatica; all recovered. One case of acute pulmonary disease. One case of diabetes.

Our town has been unusually healthy during the past year. All diseases have been manageable, and most of them curable. We have had only five deaths in a population of about eight hundred inhabitants. Births, twenty-one during the year. So you see I have had nothing of interest to report to you.

Littleton. — (950 — 16.) No small-pox. No measles. Eight or ten cases of scarlet-fever in all, and no deaths. The disease has always been of the mild form here. Two cases of cerebro-spinal meningitis; recovered. There has been but one well-marked case of diphtheria during this year (1877): that one recovered. Some mild cases of spasmodic croup. But few cases of whooping-cough. In September and October a few cases of erysipelas, all among adults. One death on the fourth day; lady of forty-two; erysipelas of the face and neck. Had a few very hard cases of typhoid fever; one death from a family where there were three sick with it. The last of summer and first of autumn an epidemic of diarrhœal diseases, most of the cases dysentery. In the fall a number of cases of rheumatism. We have had but few cases of pulmonary disease. But one case of phthisis in five years, and this did not belong to us. She moved here with it.

It has been a very healthy year here, the most so I ever remember.

Lowell. — (49,688 — 1,029.) Fourteen cases of small-pox. Measles not specially prevalent. No deaths, against sixteen in 1876. Scarlet-fever not

prevalent, and the cases generally mild. Three deaths, against five deaths in 1876. An average of 32 + deaths in the last twelve years. Scarlet-fever has greatly diminished during the prevalence of diphtheria. Cerebro-spinal meningitis has not prevailed. One hundred and forty-two deaths from diphtheria, especially prevalent in the early part of the year and during the fall: no steps have been taken to prevent its spread. Forty-two deaths from croup. Many of these, probably most of them, were cases of diphtheria. Twelve deaths from whooping-cough, an unusual number. All the deaths occurred from January to July 1. Many adults were affected, quite a number for the second time. One death from erysipelas. I have heard of but few cases of this disease, Twenty-one deaths from typhoid-fever; cases generally mild and still, as last year, accompanied with a diminished tendency to intestinal symptoms. Sixty-three deaths from cholera infantum: a small number. No prevalence of other diarrhœal diseases. Nothing remarkable as to rheumatism. Forty deaths from pneumonia. It has been less fatal than for several years. In 1873, eighty deaths; 1874, sixty-one; 1875, fifty-one; 1876, forty-seven.

Small-pox. — In May and June there were fourteen cases and four deaths. May 27, the L—— girl was reported sick at 4 Jefferson Street, a crowded and filthy locality. On May 28 there were two cases, one (A——) in a tenement looking out on Tilden Court, which is a hollow square that is made up of the back-yards of numerous tenements, inhabited chiefly by French Canadians. This entire region is poorly drained, crowded with noisome vaults, and generally dirty. The other case (B——) occurred at 19 Cabot Street. Further examination of Tilden Court led to the discovery, in one house, of two persons whose bodies were covered with recent small-pox scabs, and in the house opposite to this, an infant with varioloid. The father of the infant (C——) was forced to confess that early in May he had secretly buried a child who had died of small-pox. June 3 a case was reported from Austin Street. The remaining six cases belonged to the families already mentioned. The L—— girl had played with the children in Tilden Court. B—— had whitewashed the C—— tenement, and the Austin Street man had been in the habit of visiting A——. Isolation, disinfection, and a general vaccination were promptly applied, and the trouble was quickly ended.

On the whole we have had a healthy year. There have been only 1,027 deaths, less than in any year but one since 1870. Diphtheria has prevailed, but not so severely, on the whole, as last year. It is my belief that many lives might be saved by isolation; but, as far as I am able to learn, this has been but little practised. The city accepted the proposition for a board of health under the new law. Two men, not physicians, have been appointed, who, with the city physician, make up this new board.

Lunenburg. — (1,153 — 27.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. Only one or two slight cases of diphtheria. No croup. Two or three light cases of whooping-cough. No severe cases of erysipelas. No typhoid-fever. A large number of light cases of diarrhœal diseases. Rheumatism quite general. Three cases of

pneumonia fatal, one not yet determined. Five or six deaths from pulmonary consumption.

This is a very healthy town, hilly, with little water on the surface.

Lynn. — (32,600 — 693.) No cases of small-pox have been reported during the year. Varicella has been quite prevalent, and in several instances assumed so peculiar and severe a form as to create a strong suspicion that it was varioloid. One death only was ascribed to measles. The disease has not been widely prevalent during any portion of the year. Scarlet-fever has prevailed to a moderate extent, but the cases have mostly been mild. Five deaths were reported, a less number than for any other year since 1866. The decedents were all under ten, three of them were between two and five years of age, sixty per cent. Two deaths were reported from cerebro-spinal meningitis. There has not been a sufficient number of cases of this disease to attract public attention. Diphtheria widely prevalent and very fatal. (See remarks.) Twelve deaths were attributed to croup. In the opinion of your correspondent, these were probably nearly all cases of diphtheria, invading the larynx or beginning there. Whooping-cough very prevalent: eight deaths were ascribed to this cause. Comparatively few cases of erysipelas, and those of a mild type. Typhoid fever moderately prevalent during the autumnal months: nine deaths were reported. The mortality from diarrhœal diseases has been exceptionally small. Only thirty-two deaths were ascribed to them, divided as follows: cholera infantum seventeen, dysentery ten, diarrhœa five. (See remarks.) Rheumatism in its various forms is always prevalent. Acute rheumatism has occurred with its usual frequency and severity. From acute pulmonary diseases, there have been thirty-seven deaths, an average number: thirty-four of them were ascribed to pneumonia.

The most noticeable facts respecting the health of Lynn for the past year have been the continued prevalence and fatality of diphtheria, and the small amount of mortality from diarrhœal diseases. Diphtheria has caused ninety-four deaths, thirty less than in 1876: the disease has followed very much the same course as during the previous year.[1] On the strip of land lying along the marsh, bounded on the other sides by Market Street, Summer Street, and Western Avenue, there were in 1877, twenty deaths, in 1876, twenty-seven; while between Market Street, Summer Street, South Common Street, and Western Avenue, a territory about as large as the former, there were in 1877 two deaths, in 1876 three. The portions of the map which last year were nearly free from death-spots are so this year. There is reason to fear that in some quarters of the city the disease may hereafter be endemic, furnishing the starting-points of another general epidemic when the material for it, now nearly exhausted, shall have again accumulated. Ninety per cent of the deaths from diphtheria, and all those from croup, were of children under ten years of age; forty-four per cent of the decedents from these diseases were between the ages of two and five. Were it not for the children under ten, the disease would soon disappear. While the present plan

[1] See the map in the Eighth Annual Report.

of watching the progress of the destroyer, and doing absolutely nothing to arrest it, is followed, we may expect in the future, as in the past, an epidemic about once in ten years.

The absence of diarrhœal diseases of a fatal character during the past year has been due, probably, to the favorable weather. We have no reason to hope for a continued exemption. Taking the zymotics together, they have caused about the usual percentage of all the deaths.

The water supplied to the city is constantly improving in quality, and very little complaint of it is now made. Measures have been inaugurated looking towards a different disposal of the sewage from the present; and an elaborate report on the subject has been made by an engineer of eminence. It recommends the construction of an intercepting and out-fall sewer, discharging the sewage off Pine's Point, near the mouth of Saugus River. The report does not detail the experiments made to ascertain what would be the ultimate disposal of the sewage-mud, and in this it seems to your correspondent defective. The people of Lynn will hardly consent to the great expense involved in the proposed plan until they are satisfied whether Chelsea Beach is likely to be injured, or any other evil to result, rendering the city liable to suits for damages, and possibly enormous expense to remedy the difficulties. The suggestion contained in the report that the sewage-sludge, or precipitate, after some process of purification, might be used for filling in the harbor, should such an enterprise be undertaken, seems a remarkable one for a sanitary engineer to make. Such land would not furnish "ground air" of a very desirable quality for the dwellings or factories that might be erected upon it.

The vote at the recent election by which Lynn rejected the Act to establish a board of health was very small, and cannot justly be taken as a fair expression of the wishes of the people in respect to this important matter.

Malden. — (10,843 — 204.) No small-pox. Very few cases of measles. Scarlet-fever moderately prevalent, but generally of a mild type. No cerebro-spinal meningitis seen or heard of. Diphtheria moderately prevalent. Croup when occurring invariably diphtheritic. Whooping-cough quite prevalent. Few cases of erysipelas. Remarkably few cases of typhoid-fever. Moderate number of cases of diarrhœal diseases during summer. Rheumatism mostly of a sub-acute character. Acute pulmonary diseases much below the average.

The past year, so far as I can judge, has been far above the average in point of health. The only diseases which may be considered as having been prevalent are whooping-cough, "mumps," scarlet-fever, and diphtheria. The first-named has prevailed very extensively for the last two years, though perhaps rather less so the past year, possibly from the want of material. Parotitis has been very common among the school children since the first of December. Scarlet-fever has been moderately prevalent throughout the year, almost always of a mild type. In the exceptional cases diphtheritic poison has been added as a complication. In some of these cases it has been difficult to decide which is the primary disease. The serious sequelæ of scarlet-fever have been rare.

Of the acute diseases, diphtheria has certainly proved the most impor-

tant as well as fatal. The subjects have mainly been children under twelve years of age, the few cases among adults being generally mild. In this town there has not been, to my knowledge, a fatal case from this disease in an adult. The localities attacked here have been mostly damp and marshy: the base and slopes of hills also seem to be favorite points of attack. Here I find, that, owing to the "springy" nature of the ground, the cellars of the houses are nearly always wet during a portion of the year. During 1876 the Maplewood district and the slope of Baker's Hill suffered most from this disease. During the past year there have been few cases in these localities; while the largest number of sufferers have lived in the centre of the village, in the neighborhood of the Saugus Branch Railroad, and on the slope of Bailey's Hill. The Edgeworth district, which is the most poorly drained, has suffered but little. The fatality from this disease has been quite large, and has generally been the result of the extension of the disease to the larynx and trachea, with consequent asphyxia. The disease has not apparently been carried from house to house; but each family has been attacked, as it were, spontaneously. Isolation and thorough disinfection are undoubtedly safeguards to other members of the family; but these do not apparently present any barrier against a fresh outbreak in another house. Thus far with us, diphtheria has proved a hydra-headed disease. There have also been many cases of tonsillitis, which, although hardly to be classed as diphtheritic, were certainly of a decidedly asthenic type. Typhoid-fever has never been less frequent than during the past year. Since the introduction of Spot-Pond water, we have seen comparatively little of this disease. In Malden we have unfortunately no medical board of health. In our opinion general sanitary measures will not be efficiently carried out except under the supervision of such a board.

Marblehead. — (7,677 — 152.) No cases of small-pox. No cases of measles. Very few cases of scarlet-fever. No cerebro-spinal meningitis. Diphtheria prevalent during first months of the year; very few cases, and most of those mild, during last eight months. Few cases of croup. No whooping-cough. Few cases of erysipelas. But few cases of typhoid-fever. An unusually large number of cases of dysentery in September and October; very few cases fatal. Nothing unusual as to rheumatism or acute pulmonary diseases.

Marlborough. — (8,424 — 148.) No small-pox. Measles slightly prevalent. Scarlet-fever slightly prevalent. No cerebro-spinal meningitis. No severe cases of diphtheria; some few cases of what may be called diphtheritic sore-throat. No croup except spasmodic. Whooping-cough prevailed quite extensively during December. Few cases of erysipelas reported; none severe. Very few cases of typhoid-fever, and those light in character. Less than usual of diarrhœal diseases. Rheumatism quite extensive, much more than usual, especially during December. Very few cases of acute pulmonary diseases reported since March.

Marlborough has been remarkably fortunate in having no disease prevail extensively.

Contagious diseases have been light in character, and have prevailed to a very limited degree. Diphtheria has been scarcely prevalent, and no deaths caused by it have occurred. The number of cases of typhoid have been less than usual; but during October, November, and December cases of rheumatism multiplied rapidly. Acute pulmonary diseases in January, February, and March were prevalent, and many terminated fatally, especially where patient was of advanced age.

Mashpee. — (278 — 6.) No cerebro-spinal meningitis. One case of putrid sore throat; recovered. Three cases of croup. No whooping-cough. Two cases of erysipelas, recovered. Three cases of typhoid-fever, recovered. No diarrhœal diseases. No fatal cases of rheumatism. Two cases acute pulmonary diseases, gaining.

Mattapoisett. — (1,361 — 28.) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, diphtheria, croup, nor whooping-cough. Only one or two cases of erysipelas; slight. No typhoid-fever. No epidemic of diarrhœal diseases, nor of rheumatism. Perhaps half a dozen cases of acute pneumonia.

Our little town has been very healthy for several years. It formerly (twenty-five years since) was very sickly, with various diseases, fever chiefly; malignant scarlatina was very fatal here. Our death-rate for ten years has averaged about *fifty years of age.* I have to-day, Feb. 1, lost a patient with scarlatina; and have one other in same family; and these are the only cases, I think, I have seen for nearly or quite two years.

Maynard. — (1,965 — 27.) Not a case of small-pox. Three cases of measles. Thirteen cases, one death, from scarlet-fever. No cerebro-spinal meningitis. No diphtheria. Four cases of croup; recovered. Only a few cases of whooping-cough, treated by parents mostly. Six cases of erysipelas, no deaths. One case of typhoid-fever, recovered. Very few cases of diarrhœal diseases. Ten cases of rheumatism. Very limited amount of acute pulmonary diseases.

The health has been extremely good the past year. We have had no prevailing epidemic.

Medfield. — (1,163 — 23.) No small-pox. Few cases of measles, and mild. Fifteen to twenty cases of scarlet-fever in the month of May. The contagion traced to a supposed case of simple inflamed sore throat. No cerebro-spinal meningitis. Only three well-marked cases of diphtheria; one fatal. No membraneous croup. I think I have not seen a case of whooping-cough during the year. Erysipelas has appeared only in a mild form. Not a well-marked case of typhoid fever during the year. The number of cases of diarrhœal diseases below the average, I should think. Nothing of note as to rheumatism. Most of the cases of acute pulmonary diseases of a serious nature have been among the older class.

Medway. — (4,242 — 65.) I know of no case of genuine cerebro-spinal meningitis during the year. Very little, if any, of genuine diphtheria.

But few cases of croup. Whooping-cough not generally prevalent. But little erysipelas, and mostly of a mild type. But few cases of typhoid-fever, and those generally not malignant. Diarrhœal diseases not generally very prevalent or often severe. A few cases of acute rheumatism. Acute pulmonary diseases not prevalent.

The year 1877 has been one of remarkable health, but little of acute febrile disease.

Melrose. — (3,990 — 57.) During the past year this town has been free from any epidemic. In the summer diarrhœal diseases existed to a slight extent. Quite a number of cases of scarlet-fever, but nearly all of a very mild type: a few cases of typhoid; no diphtheria reported, so far as known.

Mendon. — (1,176 — 24.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. In January and February twelve to twenty-five cases of diphtheria. No croup, whooping-cough, erysipelas, typhoid-fever, nor diarrhœal diseases. Few cases of rheumatism. Two or three cases of pneumonia.

Mendon has thirteen hundred inhabitants. Neck Hill runs for three-quarters the distance from the northern to the southern border of the town, between Muddy Brook and Mill River in Milford, Misco, West and Wigwam hills are on the western border of the town, their western drainage emtying into West River in Uxbridge. There is but little swampy or meadow land. Nipmug Great Pond, of one hundred acres, is near the geographical centre, and empties westerly into West River. Diphtheria first appeared as an epidemic in January and February, 1877. There were some twenty-five cases, of which eleven died.

Middleton. — (1,092 — 15.) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, diphtheria, nor croup. Whooping-cough mild. No erysipelas nor typhoid-fever. Diarrhœal diseases not severe, nor more common than usual. Rheumatism common, but not severe. Acute pulmonary diseases common, but not unusually severe.

Milford. — (9,818 — 227.) Scarlet-fever was prevalent in the early part of the year, not very extensively; previous epidemics of the disease having left but few subjects to be attacked. Diphtheria was also prevailing at the same time, but, I think, not markedly so. It was more prevalent in the latter part of the year. Whooping-cough, of rather a severe type, appeared a little later in the year than scarlet-fever, and continued on to the middle of the summer; not many who were subject to it escaped. There was, so far as I could learn, less diarrhœal disease than usual. Small-pox, none. Have not heard of a case of cerebro-spinal disease the past year. Cases of typhoid-fever rare. Some cases reported of gastric fever. My impression is, that there has been no increase of cases of acute pulmonary disease the past year over the three or four years immediately preceding. Measles, of a mild type, broke out late in the autumn, and have prevailed more extensively than has any epidemic of

the kind for several years past. Croup, erysipelas, and rheumatism, nothing specially noteworthy.

Millbury. — (4,529 — 115.) No small-pox. Quite an epidemic of measles in the spring. A few cases of scarlet-fever throughout the year, not severe. Two cases of cerebro-spinal meningitis. Some cases of diphtheria throughout the year; more prevalent last autumn; not severe. A few cases of croup this winter, diphtheritic in character. Whooping-cough epidemic for the past three months. Three cases of erysipelas. Typhoid-fever quite prevalent during the autumn, of rather a mild character. Dysentery quite plenty last summer. Some rheumatism. Pneumonia quite prevalent during the autumn and winter.

I should say, that, for the past year, the health of this community has been better than for the preceding four or five years.

Monroe. — (190 — .) The health of this town has been very good the past year. None of the diseases named in the circular have prevailed to any extent; perhaps a few slight cases of diarrhœa and rheumatism, brought on by overwork and exposure.

Monson. — (3,733 — 62.) No cases of small-pox. No measles to my knowledge. Very few cases of scarlet-fever, perhaps eight or ten; only one fatal case to my knowledge, — a child of twenty months, — the brain became involved about the tenth day, resulting in spasms from effusion. No cerebro-spinal meningitis to my knowledge. Diphtheria has prevailed as never before. There may have been seventy-five cases, twelve dying from the disease proper, or from the sequelæ; one taking on erysipelas of face and head; perhaps three or four paralysis of the heart, followed by speedy death; several were followed by partial paralysis of the muscles of the vocal chords. We regard the disease as perilous, though there seem to be many mild cases, being only what I term a diphtheritic sore-throat. No croup. Only a few mild cases of whooping-cough. Not more than three or four cases of erysipelas to my knowledge, and the only fatal one reported above. Typhoid-fever has not prevailed as an epidemic; a few cases only; two reported as fatal. Several cases of cholera infantum, fatal. Not many cases of rheumatism, none fatal. We are never without more or less cases of chronic rheumatism, which is seldom fatal. There have been three cases reported as fatal, of pneumonia; there have been a number of cases of congested lungs; there is every year more or less of consumption with us; it usually leads in the number of deaths annually. The last year, I think, six or seven are reported as dying of consumption.

Aside from diphtheria, there has been no epidemic during the year. It has often been remarked by the medical profession, and outside of the profession, "We are having a very healthy year." Still there has occurred a larger than usual number of deaths, being sixty-two in a population of about thirty-three hundred, aside from the State Farm School, concerning which we make no report. This unusual number results largely from the great prevalence and fatality of diphtheria.

We, in common with the most of the towns of our size, suffer from the want of some sanitary police, selectmen, or other responsible power, whose duty it should be to remove nuisances, compel or enforce proper sanitary laws, &c. And, further, there should be penalties required of such officers as neglect to attend to their duties. As a State, we are suffering more from the failure to execute laws than from the failure to make laws. A dead law on the statute-book weakens all laws, and should be repealed or enforced, and that speedily.

Montague. — (3,380 — 85.) No cases of small-pox that I know of. Do not know of one case of measles during the year. Scarlet-fever prevailed to some extent in March and April, in a very mild form, and an occasional sporadic case at other times. Only one fatal case during the year. I think there has not been a case of cerebro-spinal meningitis during the year. Eight to ten cases of diphtheria, of a mild type, during the year; no deaths. True membraneous croup, not any: false or spasmodic croup has appeared occasionally. Whooping-cough prevailed quite extensively in some parts of the town the last of winter and spring. An occasional sporadic case of erysipelas, but no epidemic. There were several cases of typhoid-fever in July and August, some fatal; about one in ten. Very few cases after the first of September. Diarrhœal diseases were very common in the summer and early in autumn, but disappeared on the approach of cool weather. Rheumatism of a sub-acute character, accompanied with bilious derangements, has been very common during the autumn and present winter. Pneumonia prevailed quite generally in February, March, and April, and was pretty fatal. Since April there has hardly been a case.

The year has been one of general health; less sickness than the average of years past. No severe epidemic of any kind has prevailed during the year, and diseases have usually been mild in character.

Montgomery. — (304 — 4.) No small-pox. No measles. No scarlet-fever. No cerebro-spinal meningitis. Two or three mild cases of diphtheria. Two mild cases of croup. A number of cases of whooping-cough, mild. No erysipelas. No typhoid-fever. No cases of diarrhœal diseases to treat. No rheumatism. No acute pulmonary diseases.

Mount Washington. — (182 — .) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, nor diphtheria. No croup that called for medical aid. No whooping-cough, erysipelas nor typhoid-fever. Only slight cases of diarrhœal diseases. One case of rheumatism, but not fatal. No acute pulmonary diseases.

Nantucket. — (3,201 — 174.) No small-pox nor measles. Little scarlet-fever: there were a few cases in the summer; none here now. No cerebro-spinal meningitis. Diphtheria epidemic. It has prevailed here since last July; and, although abating, there are general cases here now. Croup has occurred with diphtheria in a few cases of young children less than a year old, and has proved fatal in four or five cases. Not much whooping-cough: there have been some cases. Very little erysipelas.

Some cases of typhoid-fever, perhaps a dozen in all. There have been three or four deaths. Not many cases of diarrhœal diseases; less than usual. Plenty of rheumatism always. The cases are mostly chronic: it is endemic, and with neuralgia constitutes the most prevalent ailment here. Acute pulmonary diseases not frequent. Some cases of pneumonia; fewer of pleurisy.

The population of Nantucket is about three thousand. The prevailing disease here for the last six months has been diphtheria. There have been about three hundred cases, all told. I think about twenty-five deaths. In the year 1860 diphtheria prevailed here in the spring months, and a few deaths occurred. That was its first appearance here, so far as I can learn. There were not more than fifty cases in that year, with a larger population than now. Since that time there have been a few cases every year, but never to prevail as an epidemic until the present time. I am now attending a little girl with a second attack of diphtheria. She was quite sick with it two months ago. She got well. About three weeks ago a friend of the family came to the house with two small children to stay there. The next day one of the visiting children came down with diphtheria. It ran its course, and the child is convalescent. Ten days from that child's being taken sick, my patient of six weeks previous was again taken with fever, sore-throat, white patches, and all the characteristics of decided diphtheria. She was full as sick as on the first attack. She is now getting well. The mother has also had diphtheria since this child has been sick with the second attack. She kept well during the child's first attack, although there were two children sick then. The little boy, who was sick with his sister in her first attack, keeps well so far, and waits on her and plays with her. The above was written some weeks ago. Now, January 10, 1878, I know of no case of diphtheria.

Natick.—(7,419—137.) No cases of small-pox to my knowledge. Rare cases of measles, mild in type; often no physician was called. During first quarter and last quarter, isolated cases of scarlet-fever, mostly mild in type; no epidemic; but very few deaths; exact proportion cannot be ascertained. Isolated cases of cerebro-spinal meningitis; pronounced, but none fatal in my experience. Diphtheria was more or less prevalent in early months; no cases after May until October; not largely fatal, but severe, with great depression, bearing free stimulation. Spasmodic croup quite frequent in latter part of winter; two cases of membraneous during autumn, fatal. Whooping-cough in mild form quite prevalent during autumn. Some very severe cases of erysipelas in latter part of winter; one fatal, of phlegmonous, this autumn. Typhoid-fever not prevalent; no cases known in first half of year; appeared in September; confined mostly to patients using well-water. The town is supplied from a pond. One case fatal from *hemorrhage.* No cases of diarrhœal diseases in January; one in February; none in March. One of dysentery in April; none in May; none in June; dysentery 13th July; 14th, diarrhœa began; grew more prevalent and severe throughout August and September; subsided to a marked degree after middle of October; isolated cases

till December; none after. No rheumatism in January, February, March, and April; cases in May and in June, and one in July; none in August; one, severe, in September; one or two cases in October; more prevalent in November; none in December. Cases of pneumonia, severe but not fatal, in January and February. Influenza also then severe and prevalent; none in March. Influenza prevalent in April; subsides in May; none in June; one of pneumonia, severe, in July; one also in August; September, October, and November very free from all pulmonary disease, except *asthma;* pneumonia very prevalent again in December.

The general health of Natick has improved since the introduction of aqueduct water; and cases of typhoid are almost confined to those who still use well-water, though not absolutely. Diphtheria seems not influenced by endemic conditions, unless possibly worse in damp, low localities; but is confined to no one region, sporadic cases occurring in all parts of the town, while many cases undoubtedly arise from contagion. The report under the head of each disease is as full as I could make it from my own notes, and from what information I could gather from my brethren, and is reliable as far as it goes. Natick is a town covering a good deal of ground; about six miles in diameter, with nearly seven thousand inhabitants.

New Bedford. — (25,895 — 549.) No small-pox. A slight epidemic of measles during December and January, 1878. A few cases of scarlet-fever. One or two cases of death from cerebro-spinal meningitis reported during the year. Diphtheria prevalent during the fall; not epidemic; fatal cases chiefly tracheal. A number of cases of death reported from croup; it is questionable, however, whether they were not diphtheritic. Whooping-cough mildly epidemic during November and December. Erysipelas not especially prevalent. Less cases than common of typhoid-fever, diarrhœal diseases, rheumatism, and acute pulmonary diseases.

Newburyport. — (13,323 — 287.) No small-pox. No measles. We have not had an epidemic of scarlet-fever during the year: a few cases have occurred, of a mild form. No cerebro-spinal meningitis. Diphtheria very prevalent from January to June, and of a very severe type. We have had a few cases of spasmodic croup. We had an epidemic of whooping-cough last spring, of a mild form. But few mild cases of erysipelas occurred during the year. Typhoid-fever has been more prevalent during the past year than at any time during the past twelve years. Diarrhœal diseases have been of a mild form. Since my residence in Newburyport, twelve years, I have never known so few cases of cholera infantum as we had last summer. From January to May, acute pulmonary diseases were prevalent and of a severe type. During the latter part of the year but few cases have occurred, and those have been of a mild form.

I attribute the general good health of our city to the mild, temperate weather which has prevailed during the past three months.

New Marlborough. — (2,037 — 26.) No small-pox. No measles. But one case of scarlet-fever. No cerebro-spinal meningitis. Nine cases of

diphtheria, two fatal. No croup. Acute laryngitis, one. No whooping-cough. A few comparatively mild cases of erysipelas. Bilious typhoid has prevailed to a small extent, but few cases. An unusual exemption from diarrhœa and dysentery the past year. Only one case of rheumatism of great severity; mild cases to some extent. There have not been as many cases of pneumonia as usual; more instances of bronchial inflammation.

The answers to the foregoing questions relate to my own practice. The only other physician in town is now dangerously sick so prostrated that no information can be obtained from him.

New Salem. — (923 — 18.) No cases of small-pox nor of measles. Two cases of scarlet-fever; one fatal, contracted by going into an unoccupied house where there were cases one year before. No cases of cerebro-spinal meningitis. Several ordinary cases of diphtheria; none fatal. We know of no cases of croup during the year. Whooping-cough has been very prevalent during November and December. Some have had it, who had it thirty, forty, and even fifty years ago; no cases fatal. No cases of typhoid-fever, diarrhœal diseases, nor rheumatism, have come under our observation. There have been four or five fatal cases of pneumonia of persons from seventy to eighty-five years old; and one case of a young man, aged twenty-one.

The general health of New Salem has been good for the year.

Newton. — (16,105 — 237.) Have heard of no cases of small-pox during the year. Measles prevailed to a very slight extent. A few years ago it went through the schools, and so through the town. But few cases of scarlet-fever compared with the winter of 1875–76; cases generally mild. The epidemic then was so severe that few families escaped; and there is no fresh material for it. Have heard of no cases of cerebro-spinal meningitis. Diphtheria has prevailed to a limited extent and among all classes; not so many cases this fall and winter as last. No cases of croup. In some parts of the town whooping-cough was very prevalent during the summer and fall, mild in type. No erysipelas. But very few cases of typhoid-fever indeed, and mild. Less than usual of diarrhœal diseases. Rheumatism has not prevailed to any extent. Acute pulmonary diseases about as common, though this fall (late fall) colds very prevalent and some pneumonia. Influenza quite common.

North Adams (*Adams.* — 15,760 — 246). No small-pox. Measles have been prevalent since the first of November, and the cases numerous but mild. But a single case of scarlatina has occurred in my practice the past year. Cerebro-spinal meningitis has not been prevalent, but very few cases occurring during the past year. Diphtheria has been prevalent for a length of time, and is still appearing, and I think more fatally, though the cases at present are few. The South Village, which is a populous locality, still remains free from this disease. Croup, except as a sequel of diphtheria is rare; the spasmodic form, as perhaps in other localities. I have known of no whooping-cough. Cases of erysipelas

occur frequently, and during the early part of the fall were frequent. Typhoid-fever, in a very mild form, has appeared occasionally, the first that has presented itself to me in four years. Diarrhœal diseases uncommonly mild, and a great freedom from dysentery the past fall. Rheumatism is somewhat common in this locality, but to no greater extent than previous years. Acute pulmonary diseases not common, but appearing in spring and fall to the greatest extent, but to no greater extent than usual.

With the exception of diphtheria, I think our town has been remarkably exempt from diseases of a grave character.

Northampton. — (11,108 — 144.) No small-pox. A few cases of measles. A few mild cases of scarlet-fever. No cerebro-spinal meningitis nor diphtheria. But very few cases of croup, one fatal. Whooping-cough prevailed extensively; some cases fatal, the latter generally complicated. No erysipelas to my knowledge. A number of cases of typhoid-fever, only one fatal to my knowledge. Cholera-infantum during the summer, not extensive. Rheumatism not very prevalent Pneumonia somewhat prevalent during autumn; no fatal cases uncomplicated.

The town, during the year, has been usually quite free from diseases; no epidemics of any kind except whooping-cough.

North Andover. — (2,981 — 60.) Not a case of small-pox. But very few cases of measles, and those of a light type. There have been cases of scarlet-fever through the year, not as an epidemic, but cases showing themselves here and there, which it was very difficult to trace to contagion. Most of the cases have been of a mild form and without sequelæ. Not a case of cerebro-spinal meningitis. Diphtheria has not been prevalent: still there have been a good many cases, some of which have been severe, but for the most part mild. Not a case of croup. Whooping-cough not prevalent, but a few cases from exposure in an adjoining town. No erysipelas. There have been a few cases, which have been diagnosed as typhoid-fever. I am in doubt, however, whether there has been a single case. I have not seen a case of dysentery this year. There have been, however, the usual amount of diarrhœal diseases, but of mild type, and yielded easily to treatment. There have been quite as many as usual complaining of colds and slight pulmonary troubles, but very few cases that have come under the treatment of physicians.

There has been less sickness in our town the past year than I have ever known, and most of the cases of sickness have been of a mild form.

Northborough. — (1,398 — 17.) Has been no small-pox during the year. Measles have been very prevalent since the first of December, and still prevail to some extent. There were many cases of scarlet-fever during the months of November and December. At present (February), there are a few cases. Do not know of but one case of cerebro-spinal meningitis. Have had a few mild cases of diphtheria, no deaths. Very little croup. Have been a few cases of whooping-cough. Very few cases of erysipelas. Very few cases of typhoid-fever: it very seldom prevails here to any extent. Less than usual of diarrhœal diseases dur-

ing the last year. Rheumatism not prevalent, although there have been a few cases this winter. Acute pulmonary diseases have not been prevalent. Have had a few cases of pneumonia during the last month.

North Reading. — (979 — 19.) No cases of small-pox. Eight or ten cases of measles, all in three families; all mild. A few cases of scarlet-fever of the mild form. No cases of cerebro-spinal meningitis. Two cases of diphtheria, malignant form; both fatal first week. One case reported diphtheria, but doubtful; fatal. No cases of membraneous croup. A few cases of whooping-cough, mild and uncomplicated. No cases of erysipelas. Four cases of typhoid-fever, none fatal. Very few cases of diarrhœal diseases compared with previous years. No case of cholera-infantum was observed last summer. Three cases of acute rheumatism; two with heart complications, one with inflammation of the eye. A few cases of chronic rheumatism. Seven or eight cases of pneumonia and bronchitis. One fatal case of pleuro-pneumonia.

There has been much less sickness the past year than any previous year for the past ten years.

Norwood. — (1,746 — 30.) No small-pox. Measles confined to one school-district. No real scarlet-fever. One case of cerebro-spinal meningitis; fatal. No diphtheria or croup. Twenty-five or thirty cases of whooping-cough. A few mild cases of erysipelas. More than usual of typhoid-fever, not epidemic. More than an average number of cases of diarrhœal diseases. A few cases only of acute rheumatism. Less than an average of cases of acute pulmonary diseases.

Orleans. — (1,393 — 27.) Not one case of small-pox. No measles. Very few cases of scarlet-fever and of mild type. No cerebro-spinal meningitis. Diphtheria not epidemic; several cases, but a small proportion fatal. No croup. Few cases of whooping-cough, not epidemic. No erysipelas. Some ten or twelve cases of typhoid-fever, confined to the south part of the town. Few cases of diarrhœal diseases, except those in connection with (and of course making part of) the cases of typhoid-fever. Four cases of acute rheumatism, some few chronic. Several cases of typhoid-pneumonia.

In regard to the cases of typhoid-fever, I will state that the disease has been confined to the highest, most sandy, and driest part of this town; and I have been unable to trace it to any local cause. Cistern-water is in general use; but, on inquiry, I have been told, in every instance, that the cisterns had been cleaned out some three or four months before the disease made its appearance. No cesspools or other filthy deposits were very near. Cellars reported dry, and free from decaying vegetables. Privies generally some little distance off, and ordinary cleanliness about house. Nearly every case of diphtheria has appeared in the same neighborhood (of South Orleans), and one or two cases in the same family, where typhoid-fever had previously appeared.

Phthisis, formerly one of our commonest diseases, seems to be gradually disappearing. There have been not more than four or five cases

during the year. This fact cannot be accounted for from any perceptible change in our climate, but is, I think, attributable to a more general intelligence in regard to the sources of disease and the preservation of health.

Oxford. — (2,938 — 68.) No small-pox. Measles very prevalent during the last month of the year, of a mild type. No scarlet-fever. Very few cases of cerebro-spinal meningitis, if any. Very many cases of diphtheria occurred during the last six months of the year. The number might be estimated at one hundred and fifty, and of this number some twenty died. But one adult succumbed. Comfortable circumstances, and a fair observance of the laws of health, have not exempted families from the disease, but have obviously affected the result. Its contagiousness has not been so marked as I expected. In some instances only one or two members of a large family contracted the disease, the rest escaping (for the present at least). No croup. No whooping-cough. A few mild cases of erysipelas. Much less than the usual number of cases of typhoid-fever. Diarrhœal diseases less than usual. About the usual number of cases of rheumatism. A few cases of pneumonia, pleurisy, and bronchitis, but nothing remarkable in their number or character.

Palmer. — (4,572 — 86.) Do not know of a single case of small-pox. Four deaths reported from measles. Three cases are reported in a loose way, I think. As far as I can learn they were a sequelæ, in form of bronchial inflammation and effusions. Disease did not prevail. I do not know of any cases of scarlet-fever. Not a case of cerebro-spinal meningitis, so far as I know. An epidemic of diphtheria, twenty-four deaths. Only very few cases of croup in town. No deaths, to my knowledge, from whooping-cough. No erysipelas. A few isolated cases only of typhoid-fever. No diarrhœal diseases nor rheumatism of any account. Very few cases of pulmonary diseases. Twenty are reported as having died from consumption during the year, but many so reported are among the Irish and French population, without much care, in our villages especially. The diphtheria report is, one case in May, one in July, three in August, seven in September, six in October, four in November, two in December. These are the fatal cases. I cannot give the whole number of cases in town. The disease has visited all grades, all conditions of our families. In some cases it has taken all the children of the family: all died. In other, poorer families, with bad surroundings, all have been sick, and all recovered. In one family of three children, that of an Irish farmer — not within half a mile of a neighbor, high and dry ground, a neat and tidy family, nearly new house, well-water, drainage good, no cause to be found — all died: 18th, 23d, and 26th of September. There have been five cases of diphtheria at the State Primary School under my care: all recovered. Brought there by a boy from Cohasset, — a boy sentenced by the Court. Appeared in two days after admission; was isolated, and spread but little. Of the fatal cases of consumption, more than one-half were of the foreign population. They were to be found in all classes, a majority in the poorer class. More deaths reported in 1877 than before in any one year for ten years.

Pelham. — (633 — 16.) During 1877 we have had none of the contagious diseases mentioned, except typhoid-fever. We had eight cases of that; two of which were contracted away from this town, and one of which proved fatal. One case was contracted from her mother, and could not be traced, and the balance I attributed to the sink-drain being in close contact with the well. This town has been remarkably healthy the past year. Most of the diseases that I have been called to treat were chronic diseases in old people. We had no epidemics at all.

Pembroke. — (1,399 — 19.) No small-pox nor measles. Few cases of scarlet-fever of mild type. No cerebro-spinal meningitis. Dipththeria at North Pembroke, supposed to be imported from Hanover. In all, twenty-two cases, seven fatal. The cases of death, in my experience, have been from septic poison. I believe in its contagion by inhalation. No croup. Few light cases of whooping-cough. No erysipelas nor typhoid-fever. Diarrhœal diseases not prevalent. A few cases of rheumatism. Influenza prevalent and severe.

Pepperell. — (1,927 — 47.) No small-pox. No measles. A few cases of scarlatina simplex; no deaths. No cerebro-spinal meningitis. Many malignant cases of diphtheria with death. No uncomplicated cases of croup. Whooping-cough somewhat prevalent. A few cases of erysipelas. Several cases of typhoid-fever, and some deaths. Diarrhœal diseases, rheumatism, and acute pulmonary diseases not prevalent.

During the early months of the past year, diphtheria prevailed in this town with unusual severity. That portion of the town traversed by the Nashua River, and inhabited by operatives in the mills, families of foreign parentage, received the special force and malignancy of this dreaded disease. Neither did the most prompt and approved methods of medical treatment, nor the enforcement of strict and rigid sanitary injunctions, seem to mitigate its severity, or stay, in any perceptible degree, its fatal termination. In many instances, patients, while apparently in good health, with no suspicion of what was to follow, would be seized with perhaps some slight difficulty in swallowing, with swelling of the submaxillary and cervical glands, when, on examining the throat, large patches of diphtheritic exudation would be revealed, showing what we had to encounter; death closing up the work as early as the third or fourth day from the time attention was called to the case. Diphtheria is regarded both by authors and the medical profession generally as a blood poison, propagated and intensified by unhealthy surroundings; and this, no doubt, is sufficiently true to establish the belief, yet some of the most malignant and swiftly fatal cases occurred in high altitudes, in families of scrupulous neatness, with surroundings scarcely at fault. In the late summer and early autumn months, typhoid-fever cases were somewhat prevalent, and several deaths resulted therefrom.

Petersham. — (1,203 — 29.) Scarlet-fever has prevailed quite extensively for the past year. It has been confined to localities of filth and bad drainage. We have had a few cases of diphtheria, and those in a good

and healthy locality. For the past month whooping-cough has prevailed quite extensively, affecting not only the children but grown people. Diarrhœal diseases have prevailed very extensively during the summer months, and almost exclusively among those families that used contaminated water.

Pittsfield. — (12,267 — 236.) No small-pox. A few mild cases of measles and scarlet-fever, no deaths. Two deaths from cerebro-spinal meningitis. Twenty-five deaths from diphtheria; no local epidemic. Cases scattered over the town, and mostly in the summer; almost entirely confined to the foreign population. Seven deaths from whooping-cough; epidemic and unusually severe. Seven deaths from typhoid-fever. Eleven deaths from diarrhœal diseases; nearly all cholera-infantum. Two deaths from rheumatism. Seven deaths from acute pulmonary diseases, pneumonia, and bronchitis.

The past year has been one of general good health. The summer was characterized by a great immunity from fevers and intestinal disorders, and both winters have been mild and healthy ones.

Plymouth. — (6,370 — 146.) No small-pox. No measles. But little scarlet-fever. No cerebro-spinal meningitis. Diphtheria has prevailed through every month of the year to a great extent. Whooping-cough has prevailed to a great extent. Very little typhoid-fever. Less of diarrhœal diseases than last year. But few cases of rheumatism. Less pneumonia than during the year previous.

The registration of deaths in Plymouth is subject to an error probably greater than exists in any other town of the State. Being an old town, with peculiar associations of family and history, every year a large number are brought here for interment who have died in other places, even from Maine to Illinois. Excluding these instances, the whole number of deaths in Plymouth for the year 1877 is 116, giving a death-rate of 19.3 to the thousand. Deaths occurred as follows: Jan., five; Feb., five; March, eleven; Apr., ten; May, ten; June, eleven; July, nine; Aug., fourteen; Sept., eight; Oct., ten; Nov., thirteen; Dec., ten. The largest number in August, the smallest in January. Diphtheria is the most fatal, seventeen deaths being assigned to this cause. It has prevailed in every month except May, viz.: Jan., two; Feb., one; March, two; Apr., two; June, two; July, two; Aug., two; Sept., Oct., Nov., and Dec., one each. It is not impossible that we have an allusion to this disease in the fearful mortality which visited the Cushman family of Kingston, in 1747. Consumption comes next in number, with fifteen deaths. This is a little less than the usual proportion, generally one-fifth of all deaths being charged to consumption. No death occurred from typhoid-fever, and from dysentery but two. Of teething children, from diarrhœa and cholera-infantum included, but eight. The exemption from fever and diarrhœal diseases is probably due to the pure water-supply of the town.

During the year, nineteen have died whose ages were eighty and upwards: one, of South Plymouth, was ninety-three. Ten were between the ages of seventy and eighty, and twenty-seven, children of five years and under.

Plympton. — (755 — 17.) No small-pox, measles, nor scarlet-fever. One case of cerebro-spinal meningitis. Several cases of diphtheria. None of the other diseases mentioned in the circular were prevalent.

Princeton. — (1,063 — 28.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. Twelve cases of diphtheria and two deaths; occurred in a different part of the town from last year, and not of so severe a type generally. One case of croup. No whooping-cough. Five cases of erysipelas, three of the face. One of an infant (general). One of leg. Six cases of typhoid-fever, and two deaths. Two of these in one house, seemed to be caused by a wet and very filthy cellar. Fifteen cases of diarrhœal diseases and one death (cholera infantum). Three cases of rheumatism. Eleven cases of acute bronchitis, three of pneumonia, two of pleurisy.

The health of the town has been very good, and better than last year. Mumps have prevailed to a considerable extent.

Randolph. — (4,064 — 110.) Measles have not prevailed as an epidemic. We have had a large number of cases of scarlet-fever, but of a mild type, there being but few fatal cases. No cases of cerebro-spinal meningitis to my knowledge. Diphtheria has prevailed in this town to a considerable extent, the most part of the year 1877, and quite a number of fatal cases. We are having a few cases of whooping-cough at the present time. Typhoid-fever has not prevailed to so great an extent as for two or three years previous. About the usual amount of diarrhœal diseases. There has been less rheumatism than in 1876. It used to be said that Randolph was the banner town for phthisis. Perhaps it was so formerly, but it has had little phthisis for 1877 ; and pneumonia has not prevailed this past year to so great an extent as it has in some years past.

Raynham. — (1,687 — 17.) No small-pox. But very few cases of measles. But a small number of cases of scarlet-fever. No cerebro-spinal meningitis. Only a few isolated cases of diphtheria : these seem to have been the result of contagion. Have not heard of any membraneous croup. No epidemic of whooping-cough: a few isolated cases. Only a few cases of erysipelas. More than the usual number of cases of typhoid-fever. Nearly all have open cesspools near the house. In some the water was evidently contaminated by sewage. Diarrhœal diseases not so prevalent as usual. Rheumatism more than usually prevalent during the early part of 1877. No more than usual of acute pulmonary diseases, if so many.

Reading. — (3,186 — 46.) No small-pox nor measles. Eighty to one hundred cases of scarlet-fever, mostly light, one fatal. No cerebro-spinal meningitis. Forty to fifty cases of diphtheria; three fatal. One case of croup, fatal in thirty hours. Two cases of whooping-cough. Seven or eight cases of erysipelas, not severe, sporadic. Eight cases of typhoid-fever, none fatal; two severe. Diarrhœal diseases less than the average in number and severity. Not more than a dozen cases of acute rheumatism. Fifteen to eighteen cases of pneumonia, five fatal. Bronchitis not unusually prevalent.

The health of Reading has been up to, or above, its average. The scarlet-fever has been remarkable for its mildness; few cases being severe, and only one fatal. I know of but three cases during the last six months. There have been between forty and fifty cases of diphtheria, three fatal. The first fatal case was in March, that of a little boy who died after an illness of only sixty-eight hours. No case had occurred in town for more than six weeks, and none followed it for a month, and then in a distant place. The premises were supposed to be in good sanitary condition; but in October following, it was found that the sink-drain had become obstructed, and the ground under the floor of the shed and part of the kitchen was a cesspool. This condition had existed unsuspected for a year or two. There was no perceptible odor from it. No urine nor any thing went into it, except the usual soapy water and greasy water from the kitchen. No other cases occurred in the family. The next fatal case was that of a boy, aged eight, living near the one just mentioned, who died (in June) after an illness of nineteen days. There were three other cases in the same house at the same time. No known exposure to the disease. The well, thirty or forty feet deep, was within twenty feet of the privy-vault, which was made of loose stones, and both had been used for many years. A severe case of typhoid-fever occurred in this house in the following September. The third fatal case occurred about this time: whether there had been any exposure to contagion or insanitary surroundings, I have not heard. A few cases of this disease occurred in December, 1877, and in January, 1878, which are worthy of note. A boy of ten came, Dec. 20, from Wakefield to visit his cousins, felt sick, and went home Dec. 22, and died of diphtheria Dec. 28; and later his sister and brother, all the children of the family, succumbed to the same disease. Dec. 26 a babe of eighteen months, in the family visited, was taken with what was found, Dec. 31, when a physician was summoned, to be diphtheria. Jan. 3, 1878, a sister aged twenty, and Jan. 4 a brother aged fourteen, were taken with the same disease; the latter case proving fatal in seventeen days. A former member of this family slept with the sister just mentioned the night she was taken sick, and daily went back and forth between this house and her home, one-third of a mile distant. On Jan. 9 a babe of twenty-two months, where she was living, was taken with what was found to be, when a physician was called on the 13th, diphtheria, which resulted fatally on the 15th. The father and mother of this babe, and a cousin of the mother who helped take care of her, had light attacks of the same disease. One of the watchers in the first-mentioned family also had it. Thus these eight cases, all, with one exception, that occurred about this time, can be traced to one source. Of the twenty-three cases which have fallen under my immediate observation in 1877, five were adults, seventeen were in four families. The other six cases occurred singly in six families, numbering thirty-three persons.

One fatal case of croup occurred in July, after an illness of thirty hours. There was no false membrane seen in the throat. No autopsy could be obtained. A case of diphtheria existed within twenty rods distance. There were eight cases of typhoid-fever in 1877. One has been

referred to (well contaminated from a privy). In another, the well was in suspicious proximity to sources of defilement, and a grandmother of the patient had the same disease seven years before. Three other cases occurred in one house, in which were two cases two years ago. In this building, a privy-vault of stone, cemented, was in the cellar; the privy-closet was on the first floor, opening from a back entry, immediately over which, and communicating directly with it, was the kitchen of the family in which the sickness occurred. The case that happened seven years ago was in the same part of the building. Those which occurred two years ago were in a family living in the L, under which, at that time, was a similar vault, since filled up. Other cases of malaise occurred here in connection with these, but not amounting to typhoid. The other three of the eight cases were very light. Two were undoubtedly contracted in New Hampshire, and the third apparently from one of these.

Rehoboth. — (1,877 — 47.) Ten cases of scarlet-fever; mild form, readily amenable to treatment; confined wholly to two families. Five cases of erysipelas; one fatal. Three cases of typhoid-fever. Fifteen cases of diarrhœal diseases, mostly of children. Ten cases of acute pulmonary diseases.

The past year has been one of marked health in Rehoboth, the most prevalent diseases being pneumonia and pleurisy during the spring months. This is a country town, with hardly a village of one dozen dwellings. The inhabitants are mostly of adult age, whose habits conduce to health, and deaths occur oftener from old age than from acute diseases. Younger members of families seek homes in the neighboring cities. Those left, young and old, follow mostly farming (as did their fathers), and enjoy health and a longevity that is truly remarkable.

Rochester. — (1,001 — 21.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. Diphtheria prevailed during October; two fatal cases. No fatal cases of croup. No cases of whooping-cough. A few cases of erysipelas, none fatal. No typhoid-fever. A few cases of diarrhœal diseases. Rheumatism has not prevailed to any extent. No acute pulmonary diseases. Diphtheria prevailed among the children of one school, so much as to cause a suspension of the school. Two of the children died.

Rockland. — (4,203 — 61.) No small-pox nor measles. Scarlet-fever has not prevailed as widely as in 1876; only a few cases. No cerebro-spinal meningitis. During January and February, also during the last part of November and the whole of December, we have had something of diphtheria; rather mild cases. Croup not prevalent. Little whooping-cough to my knowledge, probably half a dozen cases. Several sporadic cases of erysipelas, not very severe. Less typhoid-fever than usual. In the last four months of 1877, there have been some ten or twelve cases. Diarrhœal diseases much less general than usual. Few cases of intestinal catarrh and dysentery (sporadic) among children; three to four fatal cases. I have seen considerable rheumatism during

the year. We had some cases of pneumonia and pleuro-pneumonia in the later winter months, and during the early spring; none fatal, except in cases of very old people, so far as I recollect. Tuberculous disease of the lungs has had fully its usual number of victims.

The year 1877 has been, in this town, unusually healthy. As compared with the past six years, the number of deaths has been below the average.

Rockport. — (4,480 — 100.) No small-pox nor measles. A very few cases of scarlet-fever, isolated. One case of cerebro-spinal meningitis, not very well marked. From fifty to sixty cases of diphtheria, with ten or twelve deaths. I cannot recall a single instance, except of diphtheritic croup; all of which, with a single exception (tracheotomy), proved fatal. No whooping-cough. About the usual number of cases of erysipelas, — perhaps ten or twelve. About fifteen cases of typhoid-fever, two fatal. Diarrhœal diseases, rheumatism, and acute pulmonary diseases unusually rare.

Had it not been for diphtheria, which at one time threatened to prevail extensively in both villages, we should have had an unusually healthy year. I do not believe that filth and insanitary surroundings have any other influence in favoring the spread of this disease than by lowering vitality. While in no two adjacent houses, where direct intercourse was prevented, did it appear, not a case occurred in either of two localities where in former years typhoid-fever prevailed, and appeared to be dependent on such unfavorable conditions, which still exist. Again: in one village it seemed to be imported from Gloucester, in the other from Salem, in both of which cities it was at the time prevalent. Most of the cases could be traced to direct personal intercourse; and, in several, a distance of a quarter of a mile would intervene between the houses from which it was carried to the houses in which it broke out anew.

Rowe. — (661 — 10.) No cases of small-pox. Two or three cases of measles, not hard. No cases of scarlet-fever, cerebro-spinal meningitis, nor diphtheria. A very few cases of croup, and light with all. Whooping-cough very extensively prevalent, especially among children; not so hard as in past times. A few cases of erysipelas. Five or six cases of typhoid-fever, two of which were fatal. Very few cases of diarrhœal diseases the past year. Several cases of rheumatism, and some chronic. Four cases of acute pulmonary diseases, and all fatal.

The general health of the citizens of this town has been above the average for several years past, owing, perhaps, to the salubrious atmosphere and unusual amount of sunshine.

Rowley. — (1,162 — 26.) Ninety-seven cases of measles. Eleven cases of croup. Seven cases of erysipelas. Five cases of typhoid-fever, one fatal. Fifty cases of diarrhœal diseases, one fatal. Twenty-six cases of rheumatism. Ten cases of acute pulmonary diseases.

Russell. — (628 — 22.) No small-pox nor measles. Three cases of scarlet-fever, no deaths. No cerebro-spinal meningitis. Fourteen cases

of diphtheria, seven deaths; ages from one to fourteen years; tenements occupied clean; drainage good and well-ventilated. No croup. Five cases of whooping-cough; one death. No erysipelas. Two cases of typhoid-fever; one death. No diarrhœal diseases nor rheumatism. Seven cases of acute pulmonary diseases; two deaths.

Salisbury. — (4,078 — 75.) No cases of small-pox nor measles. Scarlet-fever quite prevalent, but of a very mild type and rarely followed by the ordinary sequelæ. No cases of cerebro-spinal meningitis. Only one case of diphtheria of malignant type, resulting from faulty drainage; several mild; no cases attributable to contagion. A few mild sporadic cases of croup. Whooping-cough quite epidemic, easily controlled. A few mild cases of erysipelas. Typhoid-fever quite prevalent, but very mild; not traceable to local causes. Diarrhœal diseases not prevalent. Occasional cases of rheumatism. The ordinary percentage of acute pulmonary diseases.

Considered as a whole, the year has been one of remarkable health. Salisbury is a farming-town, with a scattered population. The soil, as a general thing, is dry and sandy: hence we meet with few of those diseases peculiar to crowded tenement-houses and narrow streets. I have noticed, in the past ten years, a gradual increase of the death-rate from paralysis and other brain diseases, and fancy that this is attributable to a diet in which starch is too prominent a factor. Potatoes and fine flour occupy too much prominence on the bill of fare. As you are probably aware, this locality has an unenviable notoriety for all chronic throat and lung troubles.

Savoy. — (730 — 9.) No small-pox, measles, nor scarlet-fever. Two cases of cerebro-spinal meningitis. Three cases of diphtheria. One case of croup. No whooping-cough nor erysipelas. Seven cases of typhoid-fever. One case of rheumatism.

The general health of the inhabitants of this town for the past year has been unusually good.

Seekonk. — (1,167 — 23.) No small-pox. No measles for 1877, but are very prevalent at the present time. Scarlet-fever of a mild type prevailed during the summer and autumn in the central part of the town. One fatal case in the north part was reported in March. No cerebro-spinal meningitis. Diphtheria has prevailed throughout the town during the year, generally of a mild type. Two deaths in one family, in a low, swampy district, with poor surroundings, are reported: they were colored. One fatal case *reported* croup. Diphtheria existed in the immediate vicinity (North Providence), and quite fatal. No whooping-cough. No erysipelas to my knowledge. Eight cases of typhoid-fever, seven in one school-district; of these, six were school-children; two, also, one case diphtheria and one of rheumatism, from one house; filthy cesspool; well-water bad; on sandy land. Typhoid patients the year previous took water from this well. Diarrhœal diseases, rheumatism, and acute pulmonary diseases not prevalent.

The prevalence of typhoid-fever in one school-district attracted my notice, and I have called the attention of the selectmen to the same. This district has a new schoolhouse, with out-buildings, situated on a level, sandy plain, with a low swamp to the south: they use water from a neighboring well. In all the families, the surroundings, with one exception, were good.

Sharon. — (1,330 — 20.) Six cases of diphtheria. Three cases of croup. One case of whooping-cough: it is now epidemic in one school-district, but of a mild form. Four cases of erysipelas. One case of typhoid-fever. Nine cases of diarrhœal diseases. Numerous cases of cholera-morbus. Three cases of rheumatism. Thirteen cases of acute pulmonary diseases. Bronchitis, forty cases.

In looking over my books I find the number of cases of disease as designated in the circular recorded as herein stated. The cases of bronchitis were mostly of a mild character, andwere of but few days' continuance. None were fatal, nor were any of pneumonia. Three cases of membraneous croup and diphtheria resulted in death. I think the year 1877 has been the most healthy here for the last ten or fifteen. No epidemic. The town registrar informed me yesterday that there had been but twenty deaths for the year, very few from acute diseases.

Shelburne. — (1,590 — 28.) No cases of small-pox. A few cases of measles, very mild. Five or six cases of scarlet-fever in all, mild. Know of three cases of cerebro-spinal meningitis; two died. A few cases of diphtheria, mild; three or four died. Two or three cases of membraneous croup. Several cases of whooping-cough, some severe. A few sporadic cases of erysipelas, mild. Twenty cases of typhoid-fever, perhaps; not severe. Very few cases of diarrhœal diseases last summer. Rheumatism quite prevalent this fall. Many cases of acute pulmonary diseases; few deaths.

During the year 1877, there has not been as much sickness as usual in years past. I do not recollect a year in the last forty when there has been so little severe sickness as in the last. No epidemic has prevailed, and but few cases of epizoötic diseases, with perhaps the exception of influenza, which has prevailed quite extensively the past fall, though mild.

Sherborn. — (999 — 15.) No cases of small-pox. No varioloid. Twelve cases of measles in December, three of them severe, the remainder moderate. The first children were exposed to the disease in the neighboring town of Holliston; then it spread in the families to which they belonged; no deaths. Twelve cases of scarlet-fever early in the year (February and March) in East Medway, some of them severe; no deaths; no serious sequelæ. No cases of cerebro-spinal meningitis nor diphtheria. Only one or two cases of spasmodic croup. Three cases of whooping-cough, all in one family, commencing early in December, after exposure to the disease in Natick. The children were isolated. They are now

well. One severe case of erysipelas, not phlegmonous, however, in Holliston. Three cases of typhoid-fever, one of which was severe; none fatal. The usual complement of diarrhœal diseases in August and September, but of milder type than in other years. Two cases of rheumatism; one of them occurring in a boy of six or seven years of age, after exposure to cold. Two cases of pneumonia and three or four of acute bronchitis; none of them of exceptional severity.

Sherborn may be considered as an unusually healthy town. Acute diseases are not prevalent; and diphtheria is very rare, although it has prevailed to an unusual extent in some neighboring towns, as Holliston, and Saxonville in Framingham. The situation of the town is somewhat elevated, the population nowhere dense, and the inhabitants mostly engaged in agriculture.

Somerset. — (1,940 — 54.) No small-pox. Very few cases of measles. No scarlet-fever nor cerebro-spinal meningitis. Few cases of diphtheria, mostly of a rather mild type ; when croupal, fatal. Spasmodic croup not extensively prevalent. No deaths from whooping-cough. Few cases of erysipelas. Typhoid-fever does not prevail in this locality, there having been but very few cases for the past thirteen years. Diarrhœal diseases prevailed to an alarming extent and of severe type, especially amongst small children. Rheumatism very extensive, caused mostly by exposure ; yielded readily to treatment. No cardiac complications. Many cases of acute pulmonary diseases, as this climate seems especially adapted to lung difficulties ; mostly of bronchial complication.

Bilious difficulties are very prevalent here ; also acute gastritis, the latter in very many cases being in those who are employed in the iron mills and shovelling coal at the wharves, where the body is overheated, and by the too free use of cold water when in that condition.

South Abington. — (2,456 — 41.) No cases of small-pox. I have not known of any cases of measles. Only a few cases of a mild form of scarlet-fever. No cases of cerebro-spinal meningitis. A few cases of diphtheria in the spring and fall, but much milder than the year before. No cases of membraneous croup. Whooping-cough prevailed in two different localities last fall and spring, which was spread by children at school. No cases of erysipelas that I can recall. The year has been unusually free from typhoid. The summer was remarkably healthy for children in respect to all forms of intestinal diseases. Only isolated cases of rheumatism. Nothing noteworthy as to acute pulmonary diseases.

The past year has been an extremely healthy one in this town.

Southampton. — (1,050 — 25.) No small-pox or measles. Eight cases of scarlet-fever of mild form. No cerebro-spinal meningitis, diphtheria, croup, nor whooping cough. Some facial erysipelas. Eight cases of typhoid-fever, all recovered. Several cases of acute diarrhœa, all recovered. Considerable rheumatism, lasting short time, mostly muscular. Three cases of acute pulmonary diseases.

The past year has been one of unusual health with us but very few deaths resulting from acute diseases, mostly old people.

Southbridge. — (5,740 — 89.) No cases of small-pox. Few cases of measles. Not more than five cases of scarlet-fever. One case of cerebro-spinal meningitis reported — (doubtful). Seven deaths from diphtheria returned, most of them improperly. Very few cases ever occur in this town, more cases during the year 1877 than ever before. Few cases of croup. No whooping-cough. Few, if any, cases of erysipelas. Not exceeding ten cases of typhoid-fever. Diarrhœal diseases fewer than usual, and very few fatal. Rheumatism not prevalent. Acute pulmonary diseases more prevalent than any other of those named, especially during the last months of the year, taking the form of bronchitis ; the only circumstances seeming to govern its appearance being the frequent changes of temperature and thawing of the surface of the soil. The health of the south part of Worcester County, including this town, has been excellent throughout the year 1877 ; the entire mortality of this town of 6,000 population being eighty-nine, of which five were accidental deaths or infants still-born. Diphtheria has been more prevalent during the late cold, damp weather than ever before during the last thirty years. None of the cases could be clearly traceable to local causes. The exemption of the town from the prevalence of diseases due to zymotic influences, is considered to be due to its rugged, broken surface, and its loose, porous subsoil, which together furnish the most favorable conditions for surface drainage.

South Hadley. — (3,370 — 40.) No small-pox, measles, nor scarlet-fever. No decided case of cerebro-spinal meningitis. One case of diphtheria, fatal in two days from laryngeal inflammation. Surroundings dry ; high, well-drained ground. No croup. Three or four cases of whooping-cough, not severe ; taken from imported cases. One case of erysipelas, an old gentleman ; the disease extending over his whole face, and, to a considerable extent, his scalp. Health much broken ; recovered. Two cases of typhoid-fever ; one a young man, thirty-four years old, living on low, damp ground, four rods from a small stream which received the sewage of a small woollen-mill, some fifty rods above his residence, the rise and fall of which stream affected the rise and fall of the well-water, and probably contaminated it. Do not bear in mind a case of diarrhœa for which I have had to prescribe. One case of rheumatism, lad of twelve years ; chronic form, from exposure to damp and cold ; acute attack, valvular disease of the heart ; death. One case of pneumonia, about fifty years of age, from cold, after exposure to cold and damp ; fatal.

I can only reply for the first parish. The part of the town which I represent has been very healthy for the past year. We have had no prevailing sickness. The diseases have been more generally of the nervous type.

South Hadley Falls. — Diphtheria quite common, of mild type. Very little croup. Smart epidemic of whooping-cough. Very little erysipelas

or typhoid-fever. Diarrhœal diseases not so severe as in former years. Little rheumatism. Acute pulmonary diseases not uncommonly severe, but rather more than other diseases relatively.

The Connecticut Valley has been unusually healthy for a year and a half. Diphtheria is the only disease that has been at all severe. Whooping-cough is the only epidemic in this place.

South Scituate. — (1,818 — 26.) No small-pox nor measles. Scarlet-fever quite prevalent in the winter and spring. One case of cerebro-spinal meningitis, very serious, but has, after one year, partially recovered. Diphtheria prevalent in the autumn. No true croup. No whooping-cough. Few cases of erysipelas. Much less typhoid-fever than usual. Much less of diarrhœal diseases than usual, and remarkably so in regard to small children. No deaths that I remember. Rheumatism prevailed to some extent. Acute pulmonary diseases prevalent during winter and spring.

I would say the last year has been quite healthy ; notably so in regard to typhoid-fever and diarrhœal diseases.

Spencer. — (5,451 — 152.) No cases of small-pox nor measles. Scarlet-fever has prevailed during every month of the year, but there has been no epidemic : it has been endemic and mild. No cases of cerebro-spinal meningitis. Diphtheria has prevailed to a considerable extent, and has proved fatal in some cases. Few cases of membraneous croup. Few cases of whooping-cough or erysipelas. Few cases of typhoid-fever ; has not prevailed to as great an extent as in previous years. Fewer cases of diarrhœal diseases than usual. More rheumatism than usual last spring. Very few cases of acute pulmonary diseases.

Springfield. — (31,053 — 535.) Two cases of small-pox. Measles prevailed extensively and generally throughout the city; mild; not fatal. Scarlet-fever limited, but severe, and followed by the usual sequences in many cases. No cases of cerebro-spinal meningitis have occurred in my practice; have heard of none. Quite a number of severe cases of diphtheria in isolated localities, while there have been more or less mild cases. A few cases of croup, perhaps the usual number. Whooping-cough somewhat prevalent. Very few cases of erysipelas. Scarcely any typhoid-fever; more of the autumnal, continued, and gastric or functional. Nothing unusual as to diarrhœal diseases. No unusual amount of rheumatism. Influenza, catarrhal bronchitis, and now and then pneumonia, pleurisy.

The fact is, our city the past year has been unusually healthy. No prevalent or epidemic disease has existed, except measles, to any serious extent. I believe this is the testimony of physicians generally.

Sterling. — (1,569 — 22.) No small-pox. Measles prevailed to some extent in a mild form, and not confined to any particular locality. A very limited number of cases of scarlet-fever and of a very mild form. No cerebro-spinal meningitis. But one genuine case of diphtheria has

occurred. A young woman came home sick from an adjoining town, was isolated, and no other became ill of it. Only a few spasmodic cases of croup have occurred; no cases of membraneous. Whooping-cough prevailed extensively in one school-district, as healthy a locality as any in town. Every case of erysipelas has been of face and head; and all in good, clean families as any in town. No typhoid-fever. In summer many cases of diarrhœal diseases, and largely among children who were fed; nursing children escaped almost entirely; only chronic cases. Pneumonia prevailed in March and April to quite an extent; not confined to any locality. Acute bronchitis has prevailed, always near low, swamp land and undrained bogs.

The general health of the town has been, on the whole, very good.

Stockbridge. — (2,089 — 22.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. Had no case of diphtheria till Jan. 1, 1878, since which only two. "False croup" occasionally; membraneous, none. No whooping-cough nor erysipelas. Typhoid-fever entirely exceptional. Diarrhœal diseases quite common during summer and fall, easily yielding to treatment in most cases. Rheumatism not uncommon; mostly of the chronic character, and some cases most obstinate, occurring generally after exposure to cold or dampness, or both; a number of cases of acute articular. Acute pulmonary diseases of very frequent occurrence, constituting, in fact, the most frequent form of disease we have.

Stoneham. — (4,984 — 75.) No small-pox nor measles. About forty cases of scarlet-fever. No cerebro-spinal meningitis. About thirty cases of diphtheria. Six cases of croup. Fourteen cases of whooping-cough. Ten cases of erysipelas. Fifteen cases of typhoid-fever. About 140 cases of diarrhœal diseases. Sixteen cases of rheumatism. About 125 cases of acute pulmonary diseases: this includes phthisis pulmonalis.

The year 1877 was a remarkably healthy one in a period of about fifty years. The statistics herewith sent comprise the diseases attended by four physicians in Stoneham. It is a curious fact, which I have observed more than once in the course of my life, that periods of dulness of trade, involving more or less of distress for want of proper food and clothing, are always healthy periods. Not that deprivation of the necessities of life is healthy, but the absence of excesses which a scarcity of money necessitates more than counterbalances the amount of disease entailed by deprivation. The year 1877 was the dullest year for work in Stoneham since 1865; and it was one of the healthiest years, probably the healthiest. Typhoid-fever, of a dysenteric type, has almost disappeared during the last three years. The school committee and teachers faithfully carry out the plan of exclusion from school in scarlet-fever.

Stow. — (1,022 — 19.) Not a case of small-pox. A very few cases of measles, mostly managed by parents. Some fifteen cases of scarlet-fever; all recovered perfectly. No cerebro-spinal meningitis nor diphtheria. Three cases of croup. Four cases of whooping-cough. Ten cases of erysipelas, none fatal. Three cases of typhoid-fever, mildest form. No

diarrhœal diseases except six cases of dysentery. Some six cases of rheumatism. Acute pulmonary diseases limited to four or five cases, very mild.

The health of Stow people has not been as good as this year for the last eighteen years.

Sturbridge. — (2,213 — 31.) No cases of small-pox. A large number of mild cases of measles. A large number of cases of scarlet-fever, mostly mild. No cases of cerebro-spinal meningitis. A few cases of diphtheria, five or six; mild. Have not seen a case of croup nor whooping-cough. Have seen quite a number of cases of erysipelas. Have attended perhaps half a dozen cases of typhoid-fever, and there may have been as many more that I have not seen; mostly mild cases. Diarrhœal diseases were quite prevalent during the summer. Rheumatism has been quite prevalent. Acute pulmonary diseases have also been prevalent.

The year 1877 has been an unusually healthy one. Very few fatal cases of disease of any kind have occurred until December. During that month, pneumonia and acute inflammatory rheumatism were quite prevalent. Most of the cases have been unusually severe and fatal.

Sudbury. — (1,177 — 24.) No cases of small-pox nor measles. Two cases of scarlet-fever, very mild. One case of cerebro-spinal meningitis; recovered. Six cases of diphtheria and two deaths, which occurred in one family. No other members had it. They were poor, and lived in an exposed situation, but it spread no further. Very few cases of croup; of mild form. No cases of whooping-cough this year. A few cases of erysipelas of mild type. A few cases of typhoid-fever and of mild form. A few cases of diarrhœal diseases occurred the last of August and first of September, but it did not prevail to any great extent. Rheumatism has not been prevalent; but few cases, and not severe. Very few cases of pneumonia and bronchitis: neither have been very prevalent.

No contagious diseases have prevailed this year. It has been, on the whole, a remarkably healthy year, and is so at the present time.

Sunderland. — (860 — 15.) No cases of small-pox nor measles. There have been four cases of scarlet-fever in one corner of the town, in three families, at about the same time. No cases of cerebro-spinal meningitis, diphtheria, nor croup. Whooping-cough has prevailed to some extent; but I can give no definite information concerning it, as none of the cases have been under medical treatment. There have been three cases of erysipelas; two of them mild; the third of a very severe type, and fatal. There have been but two cases of typhoid-fever. In one case the cause was unknown; the other was probably due to the poison arising from sink-waste. I can give no exact statement; but there have not been more than one-third of the usual number of cases of diarrhœal diseases, in my opinion, and those have been of an unusually mild type. Two cases of rheumatism. There have been an unusually small number of cases of acute pulmonary diseases.

The past year has been remarkably healthy in this community; and such acute diseases as have prevailed have been of a milder average type than usual, with the exception of the typhoid cases, and the fatal case of erysipelas already mentioned. The death-rate is much higher than in 1876; but this is due to chronic rather than acute diseases, phthisis having six victims. The origin of the outbreak of scarlet-fever is a mystery, unless it originated from a mild form of "sore throat," which prevailed in the district where the outbreak occurred, and which I had no opportunity to observe. Why the disease did not spread is also a mystery, as almost every child in the neighborhood called on the first sick one during the first day of the eruption, before I had seen the case and warned the parents against allowing the children of other families to have access to the sick one.

Sutton. — (3,051 — 44.) From my own observation, as well as from the results of inquiry, I should say that there has been no prevalence of any of the diseases mentioned. Of small-pox and cerebro-spinal meningitis, I have known and can learn of none. Typhoid-fever prevailed to a limited extent in the village of Manchaug, a cotton manufacturing village, most of the residents of which are foreign operatives, living in crowded tenement-houses. Occasional cases of the other affections have occurred, but without any real prevalence.

Swampscott. — (2,128 — 40.) During the past year there have probably been twenty-five cases of typhoid-fever in this town; and, what has seemed very remarkable to me, three-fourths of the number have been among children from five to twelve years of age. I know of no special cause. Of the other diseases mentioned in your list, there has been nothing worthy of note.

Swansea. — (1,308 — 28.) Not a case of small-pox. Measles have been quite prevalent since November. Scarlet-fever has prevailed considerably since October, to this time; that is, there have been all the time in progress, from one to six cases. Not a case of cerebro-spinal meningitis in this town; have attended one in Somerset. A few cases of genuine diphtheria, perhaps six. Not a few of what might be called diphtheroid. Very few cases of croup; tractable. Very little whooping-cough. Very few, mild cases of erysipelas; not more than ten. Very few cases of typhoid-fever, of a mild, tractable type. Diarrhœal diseases not prevailing; very few cases and easily controlled. Very little rheumatism. A few cases of acute bronchitis requiring treatment; of pneumonia not more than ten, I think.

On the whole the health of the town of Swansea has been generally good for the year 1877. From diphtheria there have been two deaths; from scarlatina, one.

Taunton. — (20,445 — 433.) No cases of small-pox. A few cases of measles. No epidemic; we generally have scarlet-fever sporadically. I have had no cases of cerebro-spinal meningitis in 1877. Considerable

number of cases of diphtheria in the practice of all the physicians: about fourteen occurred in my practice, half fatal. Five severe cases of croup, fatal. No whooping-cough in my practice. No erysipelas. Six cases of typhoid-fever ; two severe and four mild. No diarrhœal diseases. A few cases of rheumatism. Pneumonia to a considerable extent. Phthisis is always prevalent here.

Tewksbury. — (1,997 — 16.) An epidemic of measles is now prevailing.

Tisbury. — (1,525 — 28.) During the spring and first part of summer scarlet-fever prevailed. Whooping-cough prevailed extensively during the fall and winter; few cases severe, no deaths.

The health of this town for this year has been exceedingly good ; the prevailing diseases mild. During the first part of the spring and summer scarlet-fever prevailed, but not many cases at one time, and mostly mild. The circumstances under which these diseases prevailed were not unusual. In almost every case the source of contagion could be shown, and doubtful cases could be reasonably explained.

Topsfield. — (1,221 — 13.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. Only one or two light cases of diphtheria. No croup. A few cases of whooping-cough, not severe. Four cases of erysipelas; one idiopathic, three traumatic. About ten cases of typhoid-fever; four or five were severe; one fatal case in the seventh week, after a relapse. Most of the worst cases were in tenements where the drainage was defective, and the disease in those cases may be fairly referable to that cause. Diarrhœal diseases prevailed only to a limited extent and in a light form; less this year than the average. About six cases of acute rheumatism; nearly all had had previous attacks. A considerable amount of influenza. A few cases of pneumonia, severe; two fatal cases in March.

Contagious diseases have not prevailed. The health of the town has been better than the average, and the mortality much less.

Truro. — (1,098 — 31.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. A number of cases of diphtheria and croup. No whooping-cough nor erysipelas. A number of cases of typhoid-fever, diarrhœal diseases, rheumatism, and acute pulmonary diseases.

Tyngsborough. — (665 — 9.) No small-pox nor measles. But little scarlet-fever, and very mild. Only a few cases of cerebro-spinal meningitis, and but one or two severe. No diphtheria nor croup. But little whooping-cough. Scarcely any erysipelas. No typhoid-fever. But little diarrhœal disease, and mild. Very little rheumatism. Hardly any acute pulmonary diseases.

Unusually good health during past year.

Upton. — (2,125 — 34.) No small-pox, measles, scarlet-fever, nor cerebro-spinal meningitis. There have been perhaps twenty cases of diph-

theria here; these being principally in the winter and spring, though a few cases occurred in June and July. The grade of disease was severe, five deaths occurring from the disease. Of those who recovered, about half were from four to six months in doing so. No croup, unless an occasional case of sporadic croup. Whooping-cough has prevailed to some extent, but not sufficient to come to treatment, except an occasional prescription has been called for. A very few cases of erysipelas, one of which died; the others were rather mild. From July to November, typhoid-fever was the most prominent prevailing sickness, many of the cases being severe; one death occurred. Diarrhœal diseases slight. A few mild cases of rheumatism. A few cases of acute pulmonary diseases, but not prevailing to any extent.

The past year has not been one of unusual sickness. Epidemics have not prevailed, except that of diphtheria. Local causes, such as poor drainage or no drainage, have been conspicuous in several instances where diphtheria and typhoid-fever have occurred. Habits of living and conditions produced by poverty have had an influence in some cases, but not in all.

Uxbridge. — (3,029 — 28.) No small-pox. There have been a number of cases of measles the present month, one fatal; one family from Putnam, Conn., the others not traced. Very little scarlet-fever, and mild; traceable in part to a family coming direct from Canada. Have heard of no cases of cerebro-spinal meningitis. There have been occasional cases of diphtheria; the type rather more severe than the average, still, know of no deaths. I think I have seen more croup than for several years. I do not recollect or know of any cases of whooping-cough. There have been occasional cases of erysipelas, not marked by any unusual severity or mildness. Typhoid-fever has been more frequent and more severe during the past fall than usual; in one family apparently traceable to an imperfect sink-drain communicating with the well. There has been less of cholera-morbus, cholera-infantum, dysentery, and diarrhœa than usual. Rheumatism about as usual. There is much more than usual of acute pulmonary disease at the present time. Think it was also more than usually frequent in the winter and spring months. I should consider the year 1877 to have been more free from severe diseases than the average; the summer months being more marked in this respect than the rest of the year.

Wakefield. — (5,349 — 96.) Not a case of small-pox known to have existed in the town during the year. Safe to say, *none*. The cases of measles are stated by all the members of the profession to have been few and mild. There has been (during the fall months) a rather unusual number of cases of scarlet-fever of mild form; but few severe cases, and exceedingly small mortality, considering the prevalence of the disease in the neighboring towns, Lynnfield, &c. Several cases of infantile meningitis are reported, with fatal results; but there has been no notable prevalence, nor ready reference to cause in any. There has been more than the usual number of cases of so-called diphtheria. A difficulty exists in

determining, from the statements of physicians, whether all cases so classed are true diphtheria, or not. I doubt many of them. We have had, however, some violent and fatal cases, fully representing, as I term them, both classes of the disease: 1, That in which the symptoms are more especially expressive in the throat, i.e., in the air-passages; and, 2, That in which there is marked evidence of general effect, "blood-poisoning," &c. I think we have had more of the latter than was formerly the case. Some of the cases were fairly traceable to foreign sources. In one family (death occurring) the disease had its inception while the child was on a visit to friends in the next town (Reading), at a house where there were also cases. The same difficulty exists as to differentiation between "membraneous croup" and diphtheria. I think the State Board would do a real service in informing the public as to these terms. Several cases are reported, some fatal. Clearly not the usual amount of whooping-cough for the season. How much the mild season may be responsible is, of course, only conjectural, but seems to me worthy of consideration. No cases of erysipelas of severe character are reported or heard of. I think I notice an increasing tendency in the better classes to superficial (?) erysipelatous facial inflammation, not usually severe and rather chronic in type. Far too much scarlet-fever. Some aggravated cases. Several near a covered open stream, much befouled; once reported to your Board. The usual number of cases of diarrhœal diseases, though no notable excess. Children are more sensibly dressed. A great deal of rheumatism; more than usual, owing partly, probably, to the large rain-fall of the fall months. We have had quite a large number of cases of pneumonia, some fatal, and several deaths, generally of elderly people, from phthisis pulmonalis.

I think we are a town rather subject to pneumonia and acute pulmonary diseases, both from our location and topographical features and our occupations, in shoe-shops, &c., which also induce phthisis. We have lost by death, from one or another immediate cause, a considerable, even noticeable number of old people and of middle-aged. No special etiology is associable apparently with any number of them, but the mortality has excited comment. I think there is a more generally recognized prevalence of heart implication than formerly; and it has suggested itself to me whether the observation of its increase, incident to the anxieties of war-times, made by Dr. O. W. Holmes, may not be worthy of consideration, as associated with the anxieties of hard times and their sufferings. The soil of the town is everywhere sadly contaminated by fecal and organic matters, and it is so compactly built that there can be no pure wells.

Wales. — (1,020 — 8.) No small-pox, measles, scarlet-fever, cerebro-spinal meningitis, nor diphtheria. I do not know of any case of croup. Three cases of whooping-cough. No erysipelas. A very few cases of typhoid-fever. No diarrhœal diseases. One case of rheumatism. No acute pulmonary diseases.

It is a very healthy place. We never have any of those contagious diseases; and, when we have a doctor, he finds it pretty hard work to get a living among us.

Walpole. — (2,290 — 37.) In a mild form whooping-cough has continued in the centre and east part of the town since March. Scarcely any typhoid-fever. Diarrhœal diseases not prevalent at any part of the town or season of this year. There have been a very few scattered cases of rheumatism. A few cases of bronchitis and pneumonia of a moderately severe type occurred in the spring, but since then I have scarcely heard of any.

The general health of the town has been excellent, and there has been no well marked epidemic throughout this year. This has seemed to me rather remarkable, as Norwood was visited by a pretty severe epidemic of diphtheria last spring; and Foxborough, at the opposite end of the town, was also similarly afflicted; Norfolk and Medfield, on the west, had it, and it prevailed somewhat in Sharon.

Waltham. — (9,967 — 175.) No small-pox. A few cases of measles. A few cases of scarlet-fever scattered through the year. No cerebro-spinal meningitis. Considerable diphtheria scattered through the year. No croup. A good deal of whooping-cough, and prevailing somewhat at the present time. A few cases of erysipelas. Very little typhoid-fever. Very little diarrhœal diseases. Not much rheumatism. No marked prevalence of acute pulmonary diseases.

The health of the town has been generally good for the past year. With the exception of diphtheria and whooping-cough, no marked prevalence of any disease. There has been an almost entire exemption of infantile diseases.

Ware — (4,142 — 136.) No small-pox nor measles. Few cases of scarlet-fever, and of very mild form. No cerebro-spinal meningitis. A good many cases of diphtheria, but mostly of mild type; very few fatal cases. Very little croup. Whooping-cough somewhat prevalent most of the year. Very little erysipelas. Fewer cases of typhoid-fever than usual; less protracted, less severe, and less fatal. Diarrhœal diseases only as usual in summer months, and not of severe form. Rheumatism prevailed to some extent, but much less than in some years. Some cases of pneumonia and pleuro-pneumonia, but not so many as in many years nor so severe.

There has been less sickness the past year than is the average, and fewer deaths.

Wareham. — (2,874 — 42.) No small-pox. Perhaps twenty cases of measles, all mild. About forty cases of scarlet-fever in the year: three-fourths of the cases mild; about one fourth severe; no fatal cases; very few cases followed by sequelæ. No cerebro-spinal meningitis. About thirty cases of diphtheria; five fatal; three fatal cases in one family; cause of disease in this family, defective drainage and gross neglect of sink-filth. No membraneous croup; a few cases of catarrhal and spasmodic croup. A few cases of whooping-cough. I have seen three mild cases of erysipelas, and heard of one death from this disease. Have seen and heard of perhaps ten cases of typhoid-fever; two or three

severe, but none fatal. Not an unusual number of cases of diarrhœal diseases. Two deaths from cholera-infantum. Very few cases of rheumatism, no deaths. About the usual number of cases of acute pulmonary diseases. Two deaths from pneumonia in the year, and one death recorded from influenza.

The health of Wareham and vicinity has been as good, perhaps, as the average for the past ten years; the number of deaths less than the average in Wareham. The number of deaths in 1877, forty-two; average for the past ten years, fifty-three.

Warren. — (3,260 — 70.) No small-pox. Fifty to a hundred cases of measles of mild character; no deaths. No severe epidemic of scarlet-fever; a few cases of mild character. Two or three cases of cerebro-spinal meningitis during the year. During the winter and spring months a severe form of diphtheria, with occasional cases since. In most of the cases it has *not been* possible to trace the disease to local causes; but in some instances this has been perfectly evident. There have been a number of cases of diphtheritic croup, *almost all fatal.* Very little whooping-cough. No epidemic of erysipelas. We do not have much typhoid-fever. Diarrhœal diseases have occurred principally in the families of operatives in mills, children left to care for themselves, or cared for by others, and mothers in the mills. A few cases of rheumatism, not as much as usual. Pneumonia not of as severe character as some previous years.

The only contagious disease which has prevailed to any extent in town during the past year is diphtheria. It has been very difficult, in some of the cases, to account for it from local cause or from contagion; but in the majority of the severe cases, it has been clearly traceable to either the one or the other. The very imperfect ventilation of all of our schoolrooms, together with the fact that a majority of our foreign population are not quick to detect or give attention to the early symptoms of disease, makes our village primary schoolrooms centres from which diseases are distributed through our villages. We have not a well-ventilated schoolhouse, with one exception, in town.

Warwick. — (744 — 10.) No small-pox. An epidemic of measles prevailed in one school-district in January last. It was confined wholly to this district and was of mild form. No scarlet-fever. One case of cerebro-spinal meningitis in a child aged one year; very severe; the child lived sixteen hours. One case of diphtheria, severe but not fatal; the only child in the family. No other member of the family took the disease. No croup. Whooping-cough has prevailed epidemically throughout the town. One school was broken up by it; no fatal cases. One or two mild cases of erysipelas. There have been fifteen cases of typhoid-fever, most of a severe type; two fatal. Diarrhœal diseases have not been very prevalent: they have been of a mild character. Three severe cases of rheumatism. Three cases of pleuro-pneumonia, one fatal. Several cases of acute bronchitis, none fatal.

It was very healthy till August last, when typhoid-fever commenced:

in one family, consisting of the parents and four children, all the children had the disease, and one died. The water used was pure. There were three cases in a family who lived at the head of a reservoir which was low, and exhaled a loathsome miasm: one case was fatal. The other eight cases occurred in three families who lived on hills.

It is high time that the custom of public funerals of persons dying with contagious diseases should be abolished by law. We should never endanger the living by the dead.

Washington — (603 — 8.) Contagious diseases have not prevailed in this town during the year 1877. The public health has been good.

Watertown. — (5,099 — 57.) No small-pox. I do not remember to have seen a single case of measles. An unusually small number of cases of scarlet-fever; some of them severe by reason of complications, albuminuria, and pneumonia. I had but one fatal case, that was of a feeble girl aged four, in whom death occurred at the end of four days. No cerebro-spinal meningitis. But little diphtheria. In the whole year I saw two mild cases in my own practice and one in consultation, the latter being a fatal one. Once in a while a case of catarrhal or spasmodic croup; nothing of importance. But little whooping-cough has required medical attendance. But very few cases of erysipelas, and none of them fatal. I never knew a year in which the cases of typhoid-fever were so few, and its type so light and mild. Cases of diarrhœal diseases limited in number, and, as a rule, not severe. If dysentery is included, I will say that I saw some protracted and obstinate but not fatal cases, in adults; one infant died. Less rheumatism than usual. In the whole year I did not see a patient die with ordinary pneumonia, pleurisy, or bronchitis. Two females died of catarrhal pneumonia; one at the end of six months, and the other after an illness of three weeks.

The year 1877, judged in the light of my observation and experience, was altogether an exceptional one. The total amount of sickness was unusually small. There were at no time any epidemics. The number of fatal cases was much smaller than in any previous year for a long period, and was made up very largely of the results of chronic disease of that kind which is hopeless from the beginning; and in many of the cases of short duration, such was the nature of the disease that a fatal termination in no wise invalidates the conclusion that the year was an extremely healthy one.

Webster — (5,064 — 68). Not any small-pox. Not any measles, until the present week a few cases have appeared in a mild form. During the past summer a few cases of scarlet-fever occurred in a very mild form; no deaths from it that I am aware of. A few persons have been affected with cerebro-spinal meningitis during the year. Diphtheria prevailed during the summer months more generally than ever before in this vicinity, many cases proving fatal. Cases of croup have occurred throughout the year, generally of a mild form. Whooping-cough has not pre-

vailed to any extent. Very little erysipelas, no severe cases. No epidemic of typhoid-fever; during the autumn there were a few cases. Not the usual number of diarrhœal cases. Rheumatism has prevailed to a limited extent throughout the year. Pulmonary diseases have not occurred in excess of former years, though I think there has been an unusual amount of catarrhal fever and bronchitis.

The health of the inhabitants of this town has been good during the past year. With the exception of an epidemic of diphtheria which occurred during the summer months, the town has been free from any malignant type of disease. It was observed, during the epidemic of diphtheria, that cases occurred in very different conditions in life, and in every locality, — high and low, dry and damp, sunny and shady, and in persons entirely isolated from those having it.

Wellfleet. — (1,988 — 24.) No small-pox. One case of measles; mild. Ten cases of scarlet-fever, mild. No cerebro-spinal meningitis. Eight or ten cases of diphtheria, severe; two fatal. No croup nor whooping-cough. Several cases of erysipelas, none fatal. Less typhoid-fever this year than usual. Severe epidemic of diarrhœal diseases during July; one fatal case. Large number of cases of chronic and sub-acute rheumatism; *none acute.* Phthisis has been frequent, as it always is. Pneumonia very mild. Bronchitis very mild.

Westborough. — (5,141 — 66.) No small-pox. Nineteen cases of measles, of which eighteen occurred at the State Reform School; all mild cases. Perhaps ten cases of scarlet-fever; not severe, and apparently not contagious, having their origin from atmospheric or local causes. No well-defined cases of cerebro-spinal meningitis. A few cases of well-marked diphtheria, of moderate severity; none, I think, fatal, unless it be a case of diphtheritic croup. About the usual number of cases of croup, only one fatal. Whooping-cough prevailed to some extent during the summer, but was not severe. I can find but four cases of erysipelas. Typhoid-fever not as common as in former years; the few cases were of mild type. Diarrhœal diseases were common in September, but yielded easily to proper treatment. Rheumatism was more common than usual during the spring. Bronchial and catarrhal troubles have been the most peculiar tendency during the year, tending strongly to fatal results in the end.

The health of the town has been unusually good during the year, the death-rate being only about three to four, compared with last year.

Westfield. — (8,431 — 135.) This town has been signally favored during the past year. No disease has visited us in such force as to merit the title of epidemic. A few mild cases of varioloid in the spring months, with a slight sprinkling of measles and scarlatina. No cerebro-spinal meningitis. Diphtheria to a very limited extent. Croup very rare. Whooping-cough quite prevalent during the spring and summer. Scarcely any erysipelas. The usual amount of typhoid fever during the last half of the year. Diarrhœal diseases not prominent. No rheumatism of a

severe grade. Acute pulmonary diseases have not been so common as usual.

Westhampton. — (556 — 9.) No cases of small-pox. A few cases of measles, and one death. Nothing peculiar, as far as I can learn. The two or three families that caught them had them light. Think there have been no cases of scarlet-fever ; cannot learn of any. Cannot learn of any cases of cerebro-spinal meningitis. No severe cases of diphtheria. No fatal cases of croup. A few light cases of whooping-cough. The health of the town has been quite good the year past. There has been, I think, no prevailing disease, though we always have cases of pulmonary disease.

West Newbury. — (2,021 — 41.) No small-pox. A few cases of measles. Fifteen to twenty cases of scarlet-fever, and one death. No cerebro-spinal meningitis that I know of. Fifteen to twenty cases of diphtheria, with six deaths. No croup. Whooping-cough epidemic, generally diffused over the west part of the town. A few cases of erysipelas. Very few cases of typhoid-fever, no bad ones. Unusually few cases of diarrhœal diseases. Very little acute rheumatism, but plenty of chronic. Not very many cases of acute pulmonary diseases, but the few were unusually severe.

West Springfield. — (3,739 — 62.) No small-pox. No measles that I have heard of. An epidemic of scarlet-fever broke out in one of the schools the latter part of the year, which, although only of slight extent, was very severe. Out of sixteen cases there were six deaths. It seemed to be entirely confined to the families who had children in one particular room of the school. No cerebro-spinal meningitis. No diphtheria except with the fatal cases of scarlatina, in which I did not feel confident of its being true diphtheria. No croup. Whooping-cough not especially prevalent, although one death is reported, but it was not certified to by any physician. Have not heard of any erysipelas. Two deaths reported from typhoid-fever, but it has not been present as an epidemic. Diarrhœal diseases not especially prevalent. Have seen less rheumatism than usual. Acute pulmonary diseases about as usual.

This year just passed has seemed to be unusually healthy. With the exception of the slight epidemic of scarlatina near the close of the year, there have been none of the usual epidemics; and, judging from my own experience, I should say there had been less sickness than during any year that I have been here. The total mortality has, however, reached sixty-three, which is about the general average of yearly deaths. But there seems to have been an unusual number confined to the very young and the aged ; twenty being under five years, and fifteen over sixty. I do not, however, know of any especial cause for this. The larger part of the thickly-settled portion of the town is now supplied with water by an excellent aqueduct, while the sewer is so far completed that it is in use where most needed. Both of these, especially the water, have played their part in promoting the general health of the town.

West Stockbridge. — (1,981 — 21.) No cases of small-pox nor measles. Three cases of scarlet-fever. No cerebro-spinal meningitis. Have had only two well-marked cases of diphtheria. No severe case of croup. Whooping-cough has been quite prevalent, but I have seen very few cases, all of them doing without a physician. No case of erysipelas. No typhoid-fever that I call genuine : a few cases assumed a typhoid form. Very few cases of diarrhœal diseases. Only a few cases of rheumatism. Acute pulmonary diseases not generally prevalent ; do not remember to have lost a case this year.

The inhabitants of this village depend upon the working of our iron mines for their labor : these have been comparatively idle, and the men have not worked hard, or suffered great hardships; to this I attribute our freedom from disease. I have practised here for thirteen years, and this year has been the freest from acute diseases of any year of my practice. For the last week there have been quite a number of cases of tonsillitis, but in none has there any thing like diphtheria shown itself.

Weymouth. — (9,819 —170.) No small-pox. Very few cases of measles. Scarlet-fever not epidemic ; mild in type. I know of no case of cerebro-spinal meningitis. Diphtheria has prevailed since July, 1876, constantly; some very malignant cases, almost invariably fatal ; most of the cases mild in character, and recovering. Very small number of cases of croup. No whooping-cough to my knowledge. Occasional cases of erysipelas. Typhoid-fever rather more prevalent than usual ; mild in form. Diarrhœal diseases not prevalent. More rheumatism than usual during the first part of the year. Acute pulmonary diseases about the same as usual.

Whately. — (958 — 18.) No small-pox. Measles prevailed to a considerable extent ; probably twenty cases, some quite severe, but none fatal, in June and July. One case of scarlet-fever, very light ; probably exposed while visiting in an adjoining town where the disease prevailed. The patient was not isolated, but did not communicate the disease to others. No cases of cerebro-spinal meningitis. Three or four cases of diphtheria in one family; one fatal in the month of April. Very near a locality in a neighboring town where several cases proved fatal. No croup. In the spring and summer whooping-cough was very prevalent among children, though confined to one section of the town; probably fifty cases. One fatal, in a young babe, by supervention of convulsions. One or two cases of cutaneous erysipelas in adults, mild. Ten or twelve cases of typhoid-fever in October, November, and December : youngest, sixteen years of age; oldest, sixty-five ; none fatal. (See remarks.) One fatal case of cholera infantum ; child six months old ; sanitary conditions good. Only a few cases of dysentery, none fatal. Diarrhœas of children quite prevalent, but mild and easily controlled. No rheumatism except chronic cases. A few mild cases of pneumonia in April, in children. There was one fatal case ; child, a few months old.

In one instance two members of the same family (young men) were attacked with typhoid-fever. In two instances a person living within five rods of a case took the disease. Other cases apparently had no connection.

Williamsburg. —(2,029—49.) No small-pox. Measles very prevalent during the summer and fall, of a very mild type for the most part. Have seen but three very mild cases of scarlet-fever during the year. No cerebro-spinal meningitis. No marked cases of diphtheria during the year ; some diphtheritic sore throat and easily controlled. No croup. A very little whooping-cough. But little erysipelas, There has been more typhoid in this town, and, in fact, in the surrounding towns in this vicinity, this fall than usual. Diarrhœal diseases were especially prevalent, during the summer months, with the children. But little rheumatism or acute pulmonary diseases.

Williamstown. — (3,683 — 94.) One case of small-pox. Less than half a dozen cases of measles in 1877 ; at present date, 29th of January, possibly there may be that number in town. Only five cases of scarlet-fever reported in 1877. No cerebro-spinal meningitis reported. Diphtheria has been prevalent and fatal in the first and last portions of the year. Since January none have come to my knowledge. But one case of croup, fatal. No whooping-cough, and only a little erysipelas. A few cases of typhoid-fever in 1877. Diarrhœal diseases occasional during the past summer and autumn. No acute case of rheumatism reported. Some pneumonia, not much.

For the past year the health of this community has been most excellent, — less sickness than I have ever known during a single season, in a practice of over thirty years. About the first of October a case of diphtheria was imported from an adjoining town; and from this case alone we can trace twenty-seven other cases through contact with the sick ! In a few instances where personal contact was not proven, the proof was irrefragable that the disease had been conveyed by families. Rarely are we enabled to trace so many cases (27) of any contagious disease, through an unbroken chain of evidence, to a single individual ; and to those who see no evidence of the contagiousness of diphtheria, I would ask, Is it not possible that evidence might be found if looked for? The spread of diphtheria, like that of small-pox, depends largely upon the energy with which the community meets the invasion. There can be no doubt that non-intercourse will stay its progress, and that sanitary conditions will lessen its mortality. This statement the selectmen have acted upon with commendable zeal.

The outbreak of diphtheria was mostly in November and December, and sprung mainly from one family. This family, which I designate "a," communicated it to a child of family "b," living twenty or thirty rods distant. The cases in "a" were not fatal; in "b" there were four deaths, ages four to eighteen years. The family "a" were not aware of the nature of the disease, or that they had diphtheria; and a member of that family visited family connections in the east part of the town, Blackinton, and came into a group of children representing three families. From this contact resulted death in the three families ; one each in two, and four in one, the mother and three children. A young man carried a coffin to the house of family "b" upon the death of the first in that family. This young man and his sister died, but the mother lived.

There have been, as far as I know (and that does not comprise all), about forty cases, with fourteen deaths.

Wilmington. — (879 — 10.) Two cases only of scarlet-fever, very mild; both recovered. These cases were isolated, and none have occurred in any other families in town since. These cases occurred in September last. Two cases of typhoid-fever, recovered; caused, probably, by sleeping in a very small and ill-ventilated room, and filth under the window and contamination of the water used. About ten cases of diarrhœal diseases; all recovered; three cases were dysentery, and traced in part to eating green fruit. Three cases of rheumatism of the acute form, one of seven weeks' duration; all recovered. Several cases of acute pulmonary diseases; all terminated favorably.

Winchester. — (3,099 — 44.) No small-pox. Measles prevailed somewhat in spring. Scarlet-fever slight, and on the whole not in form of an epidemic, and not severe as to type. Know of no cerebro-spinal meningitis. More diphtheria than ever before, causing more deaths than any other one disease (see remarks). Know of no croup distinct from diphtheria. Considerable whooping-cough; prevailing so in one school that no attempt was made to exclude pupils suffering from it. A few scattered cases of erysipelas; no more than usual. Typhoid-fever but slightly, very slightly prevalent. Only one fatal case, and this had an interesting etiology. Less diarrhœal diseases than usual; but their prevalence more marked in late September and October than usual (see remarks). Nothing unusual as to rheumatism. Acute pulmonary diseases about as usual. There is now an epidemic reminding one of influenza without the catarrhal symptoms; beginning with sore throat (often tonsillitis), and extending to the air-passages; urgent cough and fever, abating in a few days; confined mainly to young children; unaccompanied by eruption.

Diphtheria has been found contagious in repeated instances. The only fatal case in an adult was followed by an attack in the person of the attending physician and in the nurse, both of whom live in parts of the town distant from the patient and from each other. Both had it distinctly, though mildly. One more adult died of it. December was a month of unusual health. I mention this because so much was said vaguely about the weather being then "unseasonable" and "unwholesome."

Winthrop. — (632 — 12.) No small-pox, measles, nor scarlet-fever. No case of cerebro-spinal meningitis. Very few cases of diphtheria, and very slight. No membraneous croup. No whooping-cough, erysipelas, nor typhoid-fever. Very few cases of diarrhœal diseases, and quite manageable. A number of cases of rheumatism, but all yielded readily under treatment. Nothing noteworthy with regard to surroundings. Acute pulmonary diseases quite prevalent and rather severe, requiring stimulants and tonics from the beginning of treatment.

On the whole, our town has been remarkably healthy the past year.

Woburn. — (9,568 — 165.) No small-pox. A few cases only of measles. A mild form of scarlet-fever has existed in all the year. There were five fatal cases in 1877. No cerebro-spinal meningitis. Two deaths are reported as resulting from meningitis. So far as I am informed, not a single case of cerebro-spinal meningitis has occurred. Diphtheria has existed during every month of the year; generally of a mild type, and followed by recovery in a few days; some grave cases, eight fatal in 1877 Croup not prevalent, only as a complication of diphtheria. Three deaths returned as membraneous croup. Very little whooping-cough; no deaths. Sporadic cases of erysipelas, but none resulting fatally. This town has been quite free from typhoid-fever during 1877; three deaths returned. July, August, and September diarrhœal diseases were quite prevalent; twenty deaths from cholera-infantum, cholera-morbus, and dysentery being returned. Two deaths are reported as resulting from rheumatism, both of which were rheumatic *endo-carditis.* Pneumonia and bronchitis were quite prevalent during the first quarter of the year, with occasional cases of pleuritis. Twelve deaths were returned as resulting from those causes.

Worcester. — (49,317 — 1,059.) There has not been a single case of small-pox to my knowledge. Measles have been prevalent, not to any great extent; very mild. Scarlet-fever has been quite mild, and there have not been many cases. There have been a few sporadic cases of cerebro-spinal meningitis, quite fatal. During 1877 diphtheria has prevailed more than any previous year, and has been of a severe type. Probably many of the cases reported as croup were diphtheritic; in fact, many of the fatal cases of diphtheria ended by the disease extending into the larynx. Whooping-cough has been quite frequent; not very severe. Erysipelas not very common. Typhoid-fever unusually prevalent, but of a mild form. Diarrhœal diseases not as common as in previous years. More rheumatism than during many years; not severe. According to my experience, not as many cases of acute pulmonary diseases as usual.

Many of the cases of whooping-cough, scarlet-fever, and diphtheria could be traced directly to the schools.

Population and Number of Deaths reported in the larger American Cities in 1877.

CITY.	Date of last Census.	Population by Census.	Present estimated Population.	Deaths in 1877.
New York,	1875,	1,041,886	1,078,418	26,203
Philadelphia,	1877,	850,856	–	16,004
St. Louis,	1870,	310,864	500,000	5,660
Brooklyn,	1875,	484,616	549,000	11,362
Chicago,	1876,	407,000	440,000	8,025
Boston,	1875,	341,919	353,000	7,316
Baltimore,	1873,	302,893	360,000	7,926
Cincinnati,	1870,	222,736	280,000	[1]4,428
San Francisco,	1870,	149,473	300,000	5,505
Dist. of Columbia,	1870,	138,000	160,000	4,103
Pittsburgh,	1870,	126,000	145,000	3,408
Milwaukee,	1875,	100,775	122,980	2,243
Providence,	1878,	99,682	99,682	1,938
Cleveland,	1870,	90,000	162,000	2,903
Albany,	1875,	86,013	95,000	1,103
Rochester,	1875,	82,000	85,000	1,300
Richmond,	1875,	72,639	77,500	1,649
Charleston,	1875,	56,540	–	1,813
Syracuse,	1875,	54,400	60,000	714
Lowell,	1875,	49,688	53,000	1,029
Worcester,	1875,	49,265	52,000	1,132
Cambridge,	1875,	47,838	51,000	1,034
Fall River,	1877,	45,113	46,000	1,136
Scranton,	1870,	36,750	40,000	no record kept.
Lawrence,	1875,	34,916	36,000	875
Portland, Me.,	1870,	34,380	36,000	634
Reading,	1870,	33,930	40,109	883
Lynn,	1875,	32,600	33,000	706
Mobile,	1870,	32,034	40,000	935
Toledo,	1870,	31,584	50,000	715
Springfield, Mass.,	1875,	31,053	30,000	536
Wilmington, Del.,	1870,	30,841	40,000	754
Dayton,	1870,	30,473	37,000	424
Savannah,	1870,	28,235	–	879
Yonkers,	1870,	–	18,000	323
Knoxville,	1870,	8,682	–	185
Jacksonville,	1870,	6,912	10,000	211

[1] Also 102 deaths in public institutions of persons belonging to Cincinnati.

Diphtheria in Gloucester.

The extremity of the peninsula which extends out in a northeasterly direction, and forms the north shore of Massachusetts Bay, consists of an island from four to eight miles through, the outermost part of which is the town of Rockport, the remainder comprising all of Gloucester, except the eighth, or westerly ward.

The climate in the warm months is so salubrious, that the place has long been a resort for tourists and boarders; and there are many summer residences scattered here and there. In the autumn, winter, and spring, the chill of the easterly and northerly winds is so intense as to have become proverbial. A meteorological record has not been kept.

The soil is a loose, sandy, rapidly-drying loam, overlying rock or clay. The rock is chiefly granite, and in many places occupies a considerable portion of the surface of the ground: it is very irregular in form, its upper contour extending to varying depths, mostly quite superficial. The clay is from six to twenty feet below the surface of the ground, but is usually not found where the soil is quite shallow.

Gloucester has been settled a couple of centuries: the growth of its more thickly populated parts has been chiefly during the last thirty years. The population has increased from 6,394 in 1840, to 16,754 in 1875, of whom 8,576 were males, and 8,178 females. The people live in several villages; Lanesville and Magnolia, the two extreme, being about ten miles apart. Wards 2–5 comprise the largest village, with a population of 9,607 by the census of 1875; the most thickly populated (ward 4) has a density of only thirty persons to one acre of land.

The population of Gloucester is quite free from the extremes of wealth and abject poverty. The people are largely engaged in fishing, farming, and other out-of-door work: fishing is the chief industry. There is quite a large floating population of native and foreign, including some Portuguese, fishermen, whose families follow their changes of residence to a considerable extent. The children live largely in the open air, and those who survive the diseases of early life are tough and strong. Fresh air from the ocean circulates over the whole island unobstructed; only the westerly winds come from the land.

The land rises rather abruptly from the edge of the harbor, then quite gradually, finally falling again, or remaining nearly level, so as to form settling-places for surface water. In the second ward,

there is the only real hill, which is, by estimation, 150 feet above the level of mean high water. Surface drainage is therefore good for about one-third of the four central wards, indifferent for a quarter, and very bad for the remaining portions.

The natural advantages of Gloucester are abundance of pure air, and absence of excessive summer heat. The disadvantages are exposure to the chilling winds and moist atmosphere of the cold months; a shallow soil overlying an irregular surface of rock or clay, and consequently a moist subsoil, with many wet or damp cellars. The people are hardy, and not weakened by luxurious habits or by extreme want. Since the settlement of the town, privies have been in use, with loose-walled vaults, which allow soakage into the ground, and consequently general contamination of the subsoil and of the wells. No water-supply or sewerage has been adopted: many families get their water for domestic use by storing rain-water from the roofs of their houses in cisterns.

Such being a rough outline of the general features of Gloucester, it has seemed desirable to see how they are related to the epidemic of diphtheria, which reached its height in 1876. That disease first appeared in our registration returns in 1858. Its fatality in the State and in Gloucester since that period has been as follows: —

TABLE I. — *Deaths from Diphtheria.*[1]

YEAR.	No. of Deaths in the State.	No. of Deaths in Gloucester.	YEAR.	No. of Deaths in the State.	No. of Deaths in Gloucester.
1858, . .	18	–	1868,	297	–
1859, . .	32	–	1869,	296	6
1860, . .	258	1	1870,	242	1
1861, . .	643	19	1871,	274	1
1862, . .	663	16	1872,	273	–
1863, . .	1,420	15	1873,	310	–
1864, . .	1,231	29	1874,	502	1
1865, . .	672	12	1875,	1,200	21
1866, . .	399	3	1876,	2,610	101
1867, . .	251	–	1877,	2,612 [2]	62

[1] The statistics of the mortality for 1877, in this and in the preceding pages, were kindly furnished by the Secretary of State.

[2] Approximate.

From the table, it may be seen that the disease prevailed in Gloucester in a general way, increasing or decreasing in prevalence as it also prevailed in the State at large; except in the last year (1877), when the coincidence was much less marked. This would naturally imply the existence of some "epidemic influence"

which can be more profitably discussed in reviewing the State at large than in the present investigation with regard to Gloucester. It is also admitted that diphtheria is contagious and infectious: it is probably also dependent, more than scarlet-fever; for instance, upon local miasma of some kind or other.

Since 1874, when the present outbreak began, the registration of causes of death has been very carefully kept in Gloucester. It seldom happens that there is a failure to get a certificate from a physician when one has been in attendance. We are indebted to Mr. Somes, the city clerk, for a carefully-prepared copy of his records and for other valuable assistance.

The physicians of Gloucester have also kindly given their assistance in furnishing notes of their cases; but, as such were not kept universally, Mr. Albert Chard, who has had a large experience in similar work, was engaged to make house-to-house inspections, to ascertain the prevalence and fatality of diphtheria, and to note the sanitary condition of the houses invaded, the habits of the population, &c., according to a prepared outline. This is not an entirely satisfactory method of procedure; for some people forget, others never knew the facts desired, and a certain number change their residences from time to time. The record obtained in this way, however, is as correct as much of that which is published in our registration reports. It contains several results that are useful, even after allowing a considerable margin for error; and it has been compared with the returns of the city clerk, and the statements of several of the physicians, so that the mistakes are probably as few as may be.

By the following table, it appears that the order of the number of deaths from diphtheria in Gloucester by months is for the four years as follows, beginning with the month of least fatality: —

July, August and September, February, November, October, March, April, May, June, December, January.

TABLE II. — *Deaths from Diphtheria.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1874, .	–	–	–	–	–	–	–	–	–	–	1	1	2
1875, .	1	–	1	–	–	1	1	1	2	6	1	10	24
1876, .	10	3	9	16	11	16	5	4	3	6	9	15	107
1877, .	8	5	9	5	12	8	1	3	3	3	3	2	62
1878, .	10	2	–	–	–	–	–	–	–	–	–	–	12
	29	10	19	21	23	25	7	8	8	15	14	28	207

The deaths from croup are reported as follows: —

TABLE III. — *Deaths from Croup.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1874, .	1	–	–	–	–	–	–	–	–	2	1	2	6
1875, .	–	2	1	–	–	–	–	–	–	–	–	1	4
1876, .	1	–	–	–	2	1	–	–	1	1	2	–	8
1877, .	–	–	1	2	–	–	–	–	–	–	–	1	4
1878, .	–	–	–	–	–	–	–	–	–	–	–	–	–
	2	2	2	2	2	1	–	–	1	3	3	4	22

There were sixty-nine deaths from diphtheria in the second quarter; fifty-eight in the first; fifty-seven in the fourth; and twenty-three in the third. There were a hundred and sixteen deaths in the six cold months, and ninety-two in the warm months, — not so striking a difference as one would expect. In the three summer months the mortality was comparatively small; but the pleasant months of May and June were more fatal than the cold and blustering ones of February and March. The difference, too, between June and December and between August and February was not very great: indeed, there was a monthly increase in the aggregate number of deaths each month from February to June; so that the character of the weather appears not to be a chief factor in the causation of the disease.

It has been impossible to get records of its *prevalence* by months, except in a comparatively small number of cases. In summing up the experience of three leading physicians, who kept records of their patients, it appears that diphtheria was least prevalent in August, then increased each month until January, when the decline was just as regular to August again, except that there were more cases in April than in March. By adding the experience of a fourth physician (including "a large number of cases that get well in three days," and which were not included by the others[1]) the prevalence increased each month from August to December, and decreased from that time just as uniformly to August again. So far as could be judged from these four physicians' notes, then, the number of deaths to the persons attacked was greatest in June,

[1] Catarrhal affections are undoubtedly caused by the same poison which produces diphtheria; but they are always of short duration and mild, and are not usually classed as diphtheria, inasmuch as it is not possible to distinguish them from other mild throat affections not due to the diphtheritic poison.

which, excepting possibly October, is the pleasantest month in the year. By comparing their four hundred and thirty-seven cases (including some sore throats) with the seventy-five deaths, it seems that in their practice, up to January, 1878, diphtheria was most fatal in the following order of months, beginning with the least: —

September, January, March, February, May, November and December and July, October, June, April, August.

The death-rates of those attacked were from 30 per cent in August, to 5.5 per cent in September.

From forty deaths and a hundred and fifty-nine cases, in which every thing but genuine diphtheria is carefully excluded, the order, beginning as before with the least fatal month and ending with December, 1877, is: —

September, March, November, June, January, July, May, December, February, April, October, August.

The extremes are, as before, September and August, and the extreme rates 0 and 50 per cent.

Without giving too great weight to a limited number of observations, it appears, so far as the experience of Gloucester goes, that diphtheria has been most prevalent in January, gradually decreasing until September, and then increasing. It also seems to be a fact that the relative severity of the disease has not depended in that city upon the severity of the season of the year.

The reported deaths from diphtheria in Gloucester from January, 1874, to April, 1878, have been 208. There seemed good reason for excluding one of these: of course a small margin of error must be allowed for in the rest.

Of the 207 cases, —

19 were 1 year old, or less.
23 were 2 years old, and over 1.
36 were 3 years old, and over 2.
40 were 4 years old, and over 3.
28 were 5 years old, and over 4.
146 were 5 years old, and less.
42 were 10 years old, and over 5.
9 were 15 years old, and over 10.

One was fifteen years and five months old; three were sixteen years old; three twenty; one twenty-eight, and one twenty-nine. There was only one in which no age was given. In nine only of these cases, no physician was in attendance; and in five more no attending physician's return was procured.

By the census of 1875, the number of children up to the age of five years was only five per cent greater than that from five to ten years of age; the mortality from diphtheria under five years is,

therefore, a little more than three times as great as between five and ten years. In the third period, from ten to fifteen years of age, the number of persons is four-fifths as great as in the second; the fatality as compared with the first and second is respectively about one-fourth and one-fifteenth. Those above fifteen years of age comprise seventy-one per cent of the population, and supply only 4.83 per cent of the deaths from diphtheria.

Of the 207 who died as above, 93, or 44.93 per cent, were males, 114, or 55.07 per cent were females. Of the 4,030 children in Gloucester under ten years of age in 1875, 51.04 per cent were males, 48.96 per cent females. This fact, so far as it goes, seems to show a less power of resistance in females than in males.

Of the decedents, all but nine were born in Gloucester. Both parents were born in that city in the case of twenty-seven; of sixty-seven, the parents were Americans; in thirty-two, a single parent was a native. The parents of the rest are of various countries, and illustrate the very many elements of which the population is made up. An elaborate analysis of their nationality would be of little use, unless we knew the relative numbers of the people of the various parentages.

By the city clerk's record, the distribution of deaths by wards is as follows: —

TABLE IV. — *Deaths from Diphtheria by Wards.*

WARD.	Population by Census of 1875.	Area in Acres.	Deaths fr'm Diphtheria in 1874.	Deaths fr'm Diphtheria in 1875.	Deaths fr'm Diphtheria in 1876.	Deaths fr'm Diphtheria in 1877.	Deaths fr'm Diphtheria in 1878.	Total Deaths fr'm Diphtheria.	Death-rate for the four years per 1,000 living.
1, . . .	2,369	–	1	–	10	6	2	19	8.02
2, . . .	2,333	196.7	–	2	16	15	1	34	14.58
3, . . .	2,600	111.3	–	2	11	9	–	22	8.46
4, . . .	2,073	64 8	–	4	19	9	–	32	15.44
5, . . .	2,601	129.3	1	4	13	11	1	30	11.53
6, . . .	1,240	–	–	4	12	5	–	21	16.94
7, . . .	2,373	–	–	–	6	5	8	19	8.01
8, . . .	1,165	–	–	1	–	2	–	3	2.57
Not located, .	–	–	–	7	20	–	–	27	–
City, . .	16,754	–	2	24	107	62	12	207	12.35

Wards 1, 6, 7, and 8 extend into the country, and occupy each an area of several square miles. Ward 8, with the least mortality, is the farming district, and is the largest, being very sparsely populated. Ward 7 extends several miles, and has three small

villages. Ward 1 is East Gloucester, separated by the harbor from the rest of the city: the village has about the same density of population as wards 2 and 3. Wards 2–5, including also the contiguous part of ward 6, comprise the compact portion of Gloucester: little can be said of their sanitary condition in a general way, as distinctive from the other wards. There is low, wet land throughout the city: the facilities for constant intercommunication are better in them than in the other wards.

The epidemic began in East Gloucester: the first death was reported in November, 1874, and none other until April, 1876. The second death was reported in November, 1874, in ward 5; wards 2, 3, and 4 lying between the two. It has been impossible to trace the first cases to their origin. The epidemic virtually ceased in December, 1877, with the exception that in the village of Lanesville (part of ward 7), containing about 916 inhabitants, there was a severe epidemic of eight fatal cases in January and February, 1878. That village lies on the northerly side of the island, is exposed to the cold winds, without free access of the sun's heat, and the soil is cold and damp.

The distribution of children, who have been shown to be chiefly susceptible to the disease in the various wards, is as follows: —

TABLE V. — *Death-Rate from Diphtheria and Numbers of Children by Wards.*

WARDS.	Population by Census of 1875.	No. of Children under 5 years of age.	No. of Children under 10 years of age.	Per cent. of Children under 5 years of age.	Per cent. of Children under 10 years of age.	Death-rate for the four yrs. from Diphtheria.
1, . . .	2,369	321	623	13 54	26.29	8.02
2, . . .	2,333	341	667	14 62	28.59	14.58
3, . . .	2,600	294	606	11.31	23.31	8 46
4, . . .	2,073	236	458	11.38	22.09	15.44
5, . . .	2,601	287	577	11.03	22.18	11.53
6, . . .	1,240	161	319	12.98	25.73	16.94
7, . . .	2,373	317	596	13.36	25.12	8.01
8, . . .	1,165	124	245	10.60	21.03	2.57
	16,754	2,081	4,091	12.42	24.42	12.35

It appears, from the above table, that diphtheria has not prevailed in the various wards in conformity with the distribution of that portion of the population, who, by reason of their tender age, are most susceptible to the disease.

Only a small number (nine) of those who died of diphtheria were

born out of the city. The distribution of foreigners in the different wards of Gloucester is as follows: —

Table VI. — *Distribution of Foreigners by Wards.*

WARDS.	Population by Census of 1875.	Death-rate for the four years from Diphtheria.	Number of Foreign-born.	Per cent of Foreign-born.
1, . . .	2,369	8.02	634	26.76
2, . . .	2,333	14.58	749	32.11
3, . . .	2,600	8.46	804	30.92
4, . . .	2,073	15.44	746	35.99
5, . . .	2,601	11 53	683	27 03
6, . . .	1,240	16 94	192	15 48
7, . . .	2,373	8.01	491	20.69
8, . . .	1,165	2.57	138	11.85
City, . . .	16,754	12.35	4,437	26.48

Excepting the eighth, or agricultural ward, the highest death-rate corresponds with the lowest proportion of foreigners; the second death-rate in order is in that ward where there are most foreigners. Placing the wards in order of two each, according to their proportion of foreigners, the first group (2 and 4) has a death-rate (average of the two wards) of 15.23; the second (3 and 5) of 9.99; the third (1 and 7) of 8.23; the fourth (6 and 8) of 9.76. It would not be possible to draw any general conclusions from these figures. But, if we group the deaths according to the nativity of the parents of those who died, we have the following striking results: —

Table VII. — *Mortality by Parentage.*

WARDS.	Population by Census of 1875.	Deaths from Diphtheria.	Deaths where both Parents were Foreigners.	Deaths where one Parent was a Foreigner.	Per cent of Deaths where both Parents were Foreigners.	Per cent of Foreigners living.	Death-rate from Diphtheria for the four years.
1, . .	2.369	19	9	4	47.38	26.76	8.02
2, . .	2,333	34	20	3	58,82	32.11	14.58
3, . .	2,600	22	14	3	63.64	30.92	8.46
4, . .	2,073	32	17	8	53.12	35.99	15.44
5, . .	2,651	30	13	2	43.33	27.03	11.53
6, . .	1,240	21	5	7	23.81	15.48	16.94
7, . .	2,373	19	5	3	26.31	20.69	8 01
8, . .	1,165	3	3	–	100.00	11.85	2 57
Not located, .	–	27	21	3	–	–	–
City, . .	16,754	207	107	32	51.70	26.48	12.35

The per cent of the deaths from diphtheria of those children where both parents were natives of Gloucester was 13.04; where the parents were both American, 32.32. The results, to be entirely accurate, should embody the statistics of marriage, and should show how many natives and foreigners there are who have no children. Still the conclusion would not be vitiated that the mortality among children of foreign-born parents has been enormously greater than among those of American parentage. The foreigners represent 26.5 per cent of the population of the city: their children have furnished 67.15 per cent of the deaths, or 51.17 per cent, according as we include or exclude children having only one parent of foreign origin. Making all allowances for sources of inaccuracy in the comparison, and supposing the size of the families to be the same in both cases, the children of foreign-born parents have suffered three times as heavily as those of natives. There are several ways of explaining this fact: (1) that the race has not been fully acclimated; (2) that their children have been most exposed to sources of contagion and infection; (3) that they are more susceptible to the disease, from want of sufficient food, clothing &c.; (4) that they have less strength to recover when unwell; (5) that they live in less favorable localities; (6) that their parents have less means for giving them proper care. The foreigners, generally speaking, constitute the least independent portion of the population: they are obliged to live in the most unsuitable localities, are the most crowded together, have the least knowledge, and are the most improvident; so that all the causes of high mortality just mentioned are especially operative among them.

With reference to ascertaining the influence of certain localities, it was found that the absence of numbers on the houses, and the failure to locate thirteen per cent of the deaths, rendered a statistical comparison liable to so many errors as to render it unadvisable to attempt it. A careful house-to-house inspection was therefore made, with the endeavor to establish the locality of all the fatal and non-fatal cases. That also was found to abound in errors, from the fact that so large a part of the population move about from one ward to another; and because the information, having to depend upon the memory, and often upon the very inaccurate information, of the occupants of the various houses, was not found to correspond, either with the city clerk's record, or with the information furnished by physicians. The facts supplied from these three sources, however, have been carefully compared.

So far as this comparison goes, — and it probably would not seriously affect the final conclusion if it were possible to base the

statement upon a careful consideration of all the cases instead of upon seven-eighths of them, — it can be said that diphtheria has been most prevalent and fatal in the lowest, worst-drained, and most filthy parts of the city, where the most improvident and poorest classes are obliged to live. But there have been striking exceptions to this rule, if we consider individual streets and tenements. For the worst and most overcrowded localities have often escaped almost entirely, while many houses have been invaded where the sanitary conditions were the most favorable in the city.

It should be said, however, that the general sanitary condition of Gloucester, so far as the work of man is concerned, is in the highest degree unsatisfactory; and that probably only the great abundance of pure air, and the natural strength and health of its inhabitants, prevent the evil influences from such a state of affairs from manifesting themselves more prominently.

The house-to-house inspection, which was made with the object of localizing the cases and deaths from diphtheria, failed to give accurate results in that respect, for reasons which have been already stated; but the sanitary inspection of the houses where cases of diphtheria were reported to have occurred up to January, 1878, have afforded some useful data, which are given in the following table: —

TABLE VIII. — *Sanitary State of Houses, &c.*

WARDS.	No. of Families.	Average number in Family.	No. of Families using Well-water or Springs.	No. of Families using filtered Cistern-water.	No. of Families using unfiltered Cistern-water.	Wet or damp Cellars.	Dry Cellars.	No Cellars.	Average Distance of Well from Privy.	Average Time of cleaning Privies in years.	Death-rate from Diphtheria.
1, . . .	54	5.	42	6	6	33	14	7	70 ft.	Once in 1.8 years, .	8.02
2, . . .	61	5.2	49	4	8	36	24	1	67 "	in 3. " .	14.58
3, . . .	74	5.5	61	7	6	29	43	2	30 "	in 1.71 " .	8.46
4, . . .	43	6.	42	1	–	22	19	2	43 "	in 2.3 " .	15.44
5, . . .	48	5.2	31	6	7[1]	21	15	12	84 "	in 1.9 " .	11.53
6, . . .	18	5.	16	2	–	13	4	1	73 "	in 2 2 " .	16.94
7, . . .	27	5.	24	2	1	7	18	2	67 "	in 1.2 " .	8.01
8, . . .	6	5.8	6	–	–	4	2	–	58[2] "	in 1.3 " .	2.57
	–	–	271	28	30	165	139	27			12.35

[1] In 2 more, not fully stated.

[2] Excluding 1, at a distance of 500 feet.

It is not by any means asserted that these houses are worse than those not invaded by diphtheria. Indeed, persons familiar with the city say that they probably represent not far from an average. All that can be said with certainty with regard to the table just given is, that nearly all the privies examined are so near wells, especially with vaults loosely constructed and far too seldom emptied, that the soil and well-water are all but universally contaminated; that about half the houses probably have wet or damp cellars; and that about four-fifths of the people drink well-water. That these matters in all cases, or in most cases, are directly connected with the origin of diphtheria, or at least the chief elements in its origin and spread, it is impossible to say. It is fair to suppose they are largely responsible for the high death-rate, estimated to be twenty-five per cent of all the cases attacked, and for the prolonged period of the epidemic.

With the idea of ascertaining how largely well-water is used in Gloucester, a house-to-house visitation of wards 2 and 3 was made by Mr. Chard, with the result of finding, that, in the former, seventy per cent of the inhabitants, and in the latter fifty per cent, use well-water. The proportion among those in the same two wards who had diphtheria, and who used well-water, was respectively eighty per cent and seventy-two per cent. This fact, therefore, so far as it goes, indicates that the use of the less pure water has been a somewhat unfavorable element in predisposing to diphtheria, and in increasing its fatality.

With the object of ascertaining, so far as possible, to what extent the contamination of the soil and of the wells has taken place in Gloucester, thirty-four wells, and two specimens of soil, were examined, the latter taken just below the level of the ground-water: they were nearly all collected by the Secretary of the Board, and represent all conditions of the soil, &c., in the city, so far as that could be done. No selection was made with reference to the localizing of disease, except in the case of Nos. 11 and 12, but simply for the sake of giving the best idea possible of the character of the wells, and therefore of the soil, throughout the city. During three successive visits, an attempt was made to select "the best well in the place." The results of chemical examinations by Professor Nichols are given in the following table: —

TABLE IX. — *Results of Examination of Water.*

[Results expressed in parts in 100,000.]

Number.	Date.	Street.	Character of Supply.	Unfiltered Water. Ammonia.	Unfiltered Water. "Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. "Org. and Volatile."	Solid Residue. Total at 212° F.	Chlorine.
1	Nov. 17,	Middle St., .	Surface well, .	0.0109	0.0157	35.6	2.7	38.3	5.27[3]
2	17,	" " .	" " .	0.0075	0.0077	28.9	4.2	33.1	7.33[3]
3	17,	Bury'g-gd. Lane,	" " .	0.0445	0.0203	70.0	8.0	78.0	14.24[6]
4	17,	Cor. Sargent and Park Sts, .	" " .	0.0083	0.0120	79.2	5.8	85.0	25.39[3]
5	17,	Addison St., .	" " .	0.0088	0.0307	59.5	10.7	70.2	13.56[3]
6	17,	Granite St., .	" " .	0.63	0.0291	82.0	7.0	89.0	23.61[7]
7	17,	Rogers St., .	" " .	2.35	0.0723	198.9	6.5	205.4	55.04[7]
8	17,	Middle St., .	" " .	0.23	0.0291	61.6	7.0	68.6	9.45[7]
9	17,	Pine St., . .	" " .	0.0573	0.0093	54.2	2.9	57.1	13.08[6]
10	17,	" " . .	" " .	0.0611	0.0192	46.5	4.3	50.8	12.62[2]
11	27,	Lanesville, . .	" " .	0.0051	0.0205	19.0	4.2	23.2	5.07[1]
12	27,	" . .	" " .	0.0029	0.0075	20.2	1.8	22.0	5·21[2]
13	27,	" . .	" " .	0.0032	0.0096	19.6	5.4	25.0	5.21[2]
14	27,	" . .	" " .	0.0053	0.0149	37.0	5.0	42.0	10.71[4]
15	26,	Proctor St., .	" " .	0.0136	0.0077	70.6	5.0	75.6	16.06[5]
16	26,	Cor. High and Mason Sts., .	" " .	0.0056	0.0059	32.8	2.3	35.1	10.94[2]
17	26,	Hancock St., .	" " .	0.0101	0.0088	53.4	4.5	57.9	14.4[5]
18	26,	Prospect St., .	" " .	0.0056	0.0083	48.8	3.5	52.3	16.26[4]
19	26,	" " .	" " .	0.0048	0.0085	64.2	4.8	69.0	23.27[2]
20	26,	Friend St., . .	" " .	0.0045	0.0112	31.2	5.3	36.5	9.40[4]
21	26,	Vernon St., .	" " .	0.0061	0.0115	29.8	3.4	33.2	4.40[4]
22	26,	Cor. High St. and Dale Ave., .	Spring, . .	0.65	0.0208	70.0	8.6	78.6	20.05[5]
23	26,	E. Gloucester Sq.	Surface well, .	0.0059	0.0091	42.2	2.0	44.2	11.69[4]
24	26,	Vincent's Spring,	" " .	0.0040	0.0099	52.8	3.2	56.0	13.15[5]
25	Dec. 10,	Winchester C'rt,	" " .	0.0037	0.0085	51.0	2.0	53.0	14,28[3]
26	10,	Sayward St., .	" " .	0.0072	0.0285	47.6	9.0	56.6	9.99[3]
27	10,	Granite St., .	" " .	0.0101	0.0088	55.8	5.0	60.8	11.22[3]
28	10,	Public well, Front St., .	" " .	0.0184	0.0149	111.0	10.4	121.4	33.31[6]
29	10,	Gould Ct., . .	" " .	0.0088	0.0085	53.0	5.0	58.0	12.98[6]
30	10,	Summer St., .	Cistern, filtered,	0.0072	0.0069	4.80	0.40	5.20	0.70[1]
31	10,	" " .	" unfiltered,	0.0213	0.0067	3.20	0.28	3.48	0.69[1]
32	10,	High St., . .	Driven wells, .	0.0176	0.0088	41.4	2.4	43.8	11.02[2]
33	10,	Sargent St., .	" " .	0.0035	0.0040	23.6	6.4	30.0	8.57[2]
34	10,	Sayward St., .	" " .	0.0053	0.0029	26.2	2.2	28.4	6.33[3]
35	10,	Spring St., .	" " .	0.0669	0.0075	55.0	4.0	59.0	14.97[3]
36	10,	Gould Ct., . .	" " .	0.0112	0.0045	34.8	0.6	35.4	6.72[1]

[1] No indication of nitrates by ferrous sulphate test in unconcentrated water.

[2] Faint indication of nitrates by ferrous sulphate test in unconcentrated water.

[3] Fair indication of nitrates by ferrous sulphate test in unconcentrated water.

[4] Good indication of nitrates by ferrous sulphate test in unconcentrated water.

[5] Very good indication of nitrates by ferrous sulphate test in unconcentrated water.

[6] Marked indication of nitrates by ferrous sulphate test in unconcentrated water.

[7] Very marked indication of nitrates by ferrous sulphate test in unconcentrated water.

The accompanying note from Professor Nichols would apply, in a general way, to all the water examined. With regard to some of the samples, the question was asked in the laboratory, "Do people actually drink this water?"

BOSTON, NOV. 2, 1877.

MY DEAR SIR, — I send herewith a tabular statement of the results of the examination of ten samples of water sent by you from Gloucester,

Mass. As will appear from the analytical results, no one of the waters could be pronounced fit for drinking, and some of them show evidence of very great pollution. I may add to the figures a few observations. In the case of such waters as these, the so-called "organic and volatile matter" is not to be taken as representing with any exactness the "organic matter" present; as the heat at which the "solid residue" is ignited is sufficient to volatilize some of the mineral matter. However, in these cases a considerable portion is actually organic matter, as was evident from the deportment of the solid residue when heated. Nos. 5, 7, and 10 gave the most decided evidence of the presence of excremental matter; and Nos. 2 and 9 seemed to be the least objectionable in this respect. No doubt the large amount of chlorine is to be explained in part by the proximity of the sea, but is in part to be taken as evidence of pollution. It may be noted that several of the waters contain considerable amounts of phosphates. This would not be, in itself, evidence of contamination; as most natural waters contain a small amount, and in different localities the normal amounts would differ. I should say that the quantity present in Nos. 7, 3, and 1 would be sufficient to excite suspicion; and Nos. 5, 4, and 2 might also be classed with these, the relative quantities being in the order given. To any one in the habit of drinking pure water, the taste of these waters would cause suspicion, except in the case of Nos. 1 and 2. I have purposely given only two decimal places in the ammonia of Nos. 6, 7, and 8; because, where the quantity is so large, the accuracy is not so great. In fact, in some of the others, duplicate determinations would hardly agree beyond the third decimal place.

Yours respectfully,

WM. RIPLEY NICHOLS.

The following notes were taken at the time of collecting the various specimens of water by the Secretary of the Board: the numbers refer to the first column of the table.

1. On a ridge of high land; rock eight feet below the surface of the ground. The well supplies two houses: it is thirty feet from one privy, on the same level, and sixty feet from another privy-vault, which is six feet lower on the side of the slope; both of these privies consist of the ordinary loose vault, the latter having been emptied a year and a half ago. The well is also thirty feet from a stable: the water in the well is at a level of ten feet below the surface of the ground. No striking illness has lately been attributed to drinking this water, except possibly a mild case of fever the past summer. The water is clear, and not of noticeably bad taste.

2. On the same ridge of land as No. 1, but several hundred feet distant: the rock lies thirty to forty feet below the surface of the ground. The well is thirty feet from a vault not now used, and two hundred and fifty feet from the cesspool receiving the flushings of the water-closet. The water is a trifle opaline, and has no marked taste. No illness has been traced to the use of this water.

3. A very shallow well, with a ledge of rock quite near the surface of the soil. Several families, living in a tenement where personal hygiene is not well observed, are supplied with this water. Several privies and barns are in the immediate vicinity. The water looks clear, but has a flat, drainage taste. Sickness is very common among the people using this water, especially diarrhœal diseases, typhoid fever, and diphtheria.

4. The well is on low land, quite superficial, and in a neighborhood where there is far too little attention to cleanliness. Several families use the water; and there is much illness amongst them, a large part of which, however, may be fairly traced to very wet cellars, and inability to provide the comforts of life. The water has a bad taste.

5. A well sixteen to eighteen feet deep, in sandy soil, with ledge of rock underneath: it is 140 feet from the lower edge of a cemetery, and respectively 140 feet, 160 feet, and 170 feet distant from three privies; it supplies two families. A well in the vicinity was closed because of its bad-tasting water. This water also has a suspicious taste.

6. Well about thirty feet from one privy, and sixty feet from another: the water is about eight feet from the surface of the ground, supplies two families, and has not been known to have caused any illness. It had a fair taste, and was clean: formerly, in dry weather, a disagreeable taste has been noticed.

7. Police-station. Well at the bottom of a hill, and receiving undoubtedly a large amount of drainage from the houses and yards: it is also only 300 feet from the salt water. The use of the water has not been shown to have caused illness; but it was abandoned some time ago on account of its very bad taste and smell.

8. Well quite superficial, and thirty feet distant from the privy. The water would be suspected to contain filth from its taste, but no illness has been fairly traced to its use.

9 and 10 are 100 and 250 feet distant from a cemetery, but are also in the neighborhood of privy-vaults. Both wells are extremely superficial: both had a taste suggestive of sewage-contamination, but direct illness had not been traced to either.

11. Well has been in use twenty years, and is about ten feet deep. The privy is forty feet distant, and on top of a ledge sloping toward the well. There has been one death from diphtheria in the household using the water.

12. Well has been in use fifteen years, and is 125 feet distant from the privy; with a ledge between the two. The well is twelve feet deep and on higher land than the privy. There has been one death from diphtheria among the people using this water.

13. This well is in a cellar, is ten feet deep, is respectively twenty and fifty feet distant from two cesspools used for kitchen-slops, and is sixty feet from a privy standing on ground eight feet higher. No evident illness has been traced to this well.

14. Well is ten feet deep, the bottom being on a solid ledge; privy is a hundred feet distant, higher up on the hill-slope, and with a ledge of rock between it and the well. The well has been used for thirty-five years: a half-dozen families now drink the water from it; and no illness has been attributed to it, all the families enjoying excellent health.

15. Well sixteen feet deep, the water standing four feet from the surface of the ground, dug nine months previous to time of examination, through a layer of gravel, one of clay, and to a water-bearing gravel. The water looks clear, but has a taste indicative of contamination. The clay through which this well was dug was quite black, and emitted an odor of sulphuretted hydrogen. One privy is seventy-five feet, and another a hundred and seventy-five feet, from the well: no illness has been attributed to its use.

16. Well on high land; in use many years. Privy is a hundred feet distant. The water looks clear, but has a suspicious taste. There have been recently a few cases of fever in the household using this water.

17. Well dug fifty years; formerly seventeen feet deep; in 1876 deepened three feet on account of the bad state of the water. Privies and cesspools in the immediate neighborhood. The water looks clear, but has a taste indicative of contamination. There has been typhoid-fever in this household.

18. Well on high point of land, with a downward slope in all directions and in the street. The water looks clear, and had a slightly suspicious taste. No illness attributed to its use.

19. Well in gravel in a hollow of rock; several privies within a hundred feet. There has been a case of typhoid-fever in this household, the origin of which could not be traced.

20. Town-pump, used by a large number of families and by the scholars attending the school near by. There is a swamp within twenty feet. The nearest privy or stable is two hundred feet distant. No illness has been traced to the use of this water: it looks clear, and has not any distinctly bad taste.

21. Surface-well, at the highest point of the city. An old privy, thirty feet distant, was thought to have been the cause of a bad taste in the water, and it was removed to a distance of sixty feet; another privy, a neighbor's, is seventy-five feet distant. The water in the well is about six feet from the surface of the ground: the soil is gravel, with numerous bowlders of rock. The water has

had a bad taste: at time of examination it was clear, and not disagreeable in taste. No illness has been attributed to its use.

22. A spring, never dry, the water being two feet from the surface of the ground, which is the general level of the ground-water. This part of the city has been settled (now thickly so) for a century. Three families use the water from this spring, and are "always well."

23. Public well in East Gloucester, three hundred feet from salt water: several privies are within a hundred feet of it, the nearest eighty feet distant. The well has been dug about thirty years, and was blasted out of solid rock: it is twenty feet deep. The well is never dry: twenty-five families use it; and the water is clear, and without any suspicious taste. The people in the vicinity are exceptionally healthy.

24. Public well, in use about a hundred years by several families and many passers-by. It is thought that several hundred persons often drink this water in one day. There is a slightly suspicious taste, but no want of clearness in the water.

25. A well twenty-three feet deep, with the wall carefully and tightly cemented: it is in gravelly soil, and on a summit of high land. There are two privies sixty feet distant, and others not far off. The water is clear, has an excellent taste, and is thought to be among the best in the city. No illness has been attributed to its use.

26. Surface-well, eight feet deep, close to the street, with several privies near by.

27. ——— Block. Well at the head of a hollow between two rocky ledges, and running down to salt marsh. The region is wet, and the cellars are all damp. The well supplies several families; among whom one young lady, who is a great water-drinker, has had two attacks of typhoid-fever. No bad taste or appearance to the water.

28. Public well opposite the Atlantic House, at the side of the street. The water looks clear, but has a very bad taste; is used by many people.

29. Gould Court. Surface-well, seventeen feet deep, used about twenty years. The water has a bad taste; and in the families using it there has been no unusual illness.

30 and 31. Cistern-waters, filtered and unfiltered. This water was examined by request, as there had been two deaths from diphtheria in the house. The residents are very intelligent, of unexceptionable habits; and the house is new, and well situated on the top of a hill. It is placed on a ledge of rock, and is one of the few houses in Gloucester having water-closets; and these discharge

into a rock-bound cesspool, from which there is likely to be, at times, an escape of sewer-gas into the houses.

32. Driven-well,[1] twenty-seven feet deep, through sand and gravel, on a high ledge of land. The water is clean and of good taste. No illness has been attributable to it.

33. Driven-well, through seven feet of heavy soil, and thirteen feet of clay, into a water-bearing stratum of sand and gravel. It is in a low, wet, swampy region; and seven other wells of this sort supply the neighborhood. The water is clear and of good taste.

34. Driven-well, two hundred feet from No. 28, in low, marshy land. One privy is twelve feet distant, and a stable is within sixty feet. The water tastes and looks well enough.

35. Dye-house. Driven-well, seventeen feet deep through sand and gravel, then through a layer of clay to gravel; only a few hundred feet from the harbor, and at the foot of a populated hill.

36. Driven-well, twenty-five feet deep, and fifty feet distant from No. 35. Privies and slop-water spouts are near by. The well has been in use five weeks, and passes through two layers of clay.

The two specimens of cistern-water, Nos. 30 and 32, are from a house which is new, and show that rain-water, when carefully collected and properly filtered, may be a satisfactory source of supply. The filtering-wall, however, is usually kept in service too long, so that the pores of brick in course of time become largely clogged with organic matter, so as to seriously retard the flow, and to render the filtered water as bad as the unfiltered, and in some cases *actually worse*. Many of the cisterns in Gloucester have no filters at all, and the water supplied by them must be quite impure. This matter, however, has been referred to in the paper on filtration of potable waters, and need not be further discussed here.

Driven-wells usually get their water from much deeper strata than the surface-wells. But the configuration of the soil in Gloucester, and its structure, render the two supplies practically the same, especially as the driven-wells are only from seventeen to twenty-seven feet deep. A few of them, however, pass through a thin layer of nearly impervious clay; but the water-bearing gravel below has been found to yield water having a disagreeable taste, until some of it had been allowed to stand, and had been pumped off. All that were examined, Nos. 32–36, are somewhat contaminated, and are not desirable as drinking-water: in time of an epidemic, of diarrhœal disease or of typhoid-fever, they cer-

[1] An iron pipe driven forcibly down to a water-bearing stratum: its end is perforated, to allow free passage of the water.

tainly would be unsafe to drink. It has not been possible to trace any illness directly to the use of any of these wells: no cases of diphtheria have occurred in the households drinking of them. Nos. 32 and 35 may be fairly considered bad. Nos. 33 and 34 have very little ammonia or albuminoid ammonia; but the considerable quantities of nitrates and chlorine render them liable to suspicion. No. 36 had been in use only a few weeks, is twenty-five feet deep, and happens to pass through two strata of clay: still it must be considered undesirable water. The small amount of "albuminoid ammonia" in all four indicates that the organic matter present has been almost, if not quite, oxidized.

Of the remainder of the series, four are from public wells (Nos. 18, 20, 23, 28): they are all too impure to be used; but it would be naturally impossible, except in case of some violent epidemic, to trace any illness through the several families using the water. The wells are not as bad as many others; and the only thing that can be said with any degree of certainty is, that no illness has occurred which has been noticeably attributed to their use. Such may have occurred among the fevers, &c., that have visited the families in the neighborhood, where no satisfactory predisposing cause has been found.

Twenty-five wells remain in our list; and among them there are seven (Nos. 3, 11, 12, 16, 17, 19, 27) where sickness has occurred. Of the four taken in Lanesville, Nos. 11–14, the two where cases of diphtheria occurred, were no worse than the other two, and not nearly as bad as many that were examined where there had been no illness. In the other four, Nos. 16, 17, 19, 27, the illness was chiefly fever of some sort. In No. 3 the water was used by several families in rather a wretched condition, and where there were many other more potent causes of illness: disease of various kinds, including diphtheria, prevailed there.

The thirty-four samples of well-water probably represent fairly the wells used for drinking-purposes in Gloucester. It is doubtful whether any better can be found there than Nos. 2 and 16, which are situated in the rare places having a depth of forty feet of soil; and yet they show an amount of contamination which suggests unpleasant ideas, and which would make a chemist or a sanitarian take some pains not to drink of them. No. 7 is worth twice as much for a manure as ordinary sewage, but its use has been discontinued for some time. It was the only sample in the whole series which revealed marked indication of impurity to the eye.

Of the worst specimens in use, both as valuable for a manure as the sewage taken from the Pittsfield sewers, No. 22 is from a well which has been dug for a century, and is used by three fami-

lies who are "always well." A family of robust children, types of health, have been brought up on No. 6, without any illness that could be fairly laid to the use of that water.

As regards diphtheria in connection with these thirty-six specimens, the worst cases occurred where the best water was used: two cases occurred where Nos. 11 and 12 were used, which were examined for that reason, and which proved to be none of the worst. Disease, including diphtheria, is ever present in the tenement using water from No. 3, and otherwise living in very insanitary condition.

If diphtheria is, strictly speaking, a filth-disease, it is impossible to avoid the conclusion that filthy drinking-water cannot alone engender it, or be the *chief* cause in its propagation.

The contamination of the wells, however, is an index of the pollution of the soil; and this fact is brought out more clearly by an examination of the earth taken in two places in the slight depression between Middle and High streets. The results show that in both spots the soil was somewhat filth-sodden. No. 21 had an offensive odor when first dug; and a well recently sunk, near by, had foul-smelling water for several days. A hole dug where No. 20 was taken also soon partially filled with water having an offensive taste and smell. The results of the examination of the soil are given in the following note of Professor Nichols.

BOSTON, Jan. 2, 1878.

Dr. C. F. FOLSOM.

My dear Sir,—I send herewith the results from those samples of Gloucester soils. The specimens I call Nos. 20 and 21.

Nnmber 20 was a yellowish mixture of clay and sand, a mud, in fact, containing no large pebbles. Some idea of the physical character of the material was gained by taking a portion, and washing off the clay and the finer portion of the sand: 16.15 per cent, by weight, of the wet mud was left as coarse sand and small pebbles. The material was saturated with water, and well compacted by the jarring to which it had been subject during transportation. In the condition received, the specific gravity was 2.02; or, a cubic meter would weigh 2,020 kilograms. On thorough drying at 212° F., it lost 16.83 per cent of its weight. When boiled with water, a very slight amount of sulphuretted hydrogen was evolved, which amount was not appreciably increased by addition of acid. The aqueous extract obtained by treating five grains with 15 c. c. of water gave indication of the presence of a small amount of nitrates.

The dry material lost, on ignition, 1.39 per cent; in part due to the destruction of organic matter, and in part to the loss of "water of hydration" of the clay. The total nitrogen in the dry mud was found to be 0.15 per cent (determined by Varrentrapp and Will's method).

The specimen No. 21 was very dark-colored, but otherwise agreed in description with No. 20. The specific gravity of the mud, as received, was 2.09; and it contained 14.79 per cent of water. Washed as the previous sample was, there were left small pebbles and coarse sand amounting to 28.18 per cent of the wet mud. There were no very large pebbles. When the mud was boiled with water, a small amount of sulphuretted hydrogen was evolved; treatment with acid caused a rapid evolution of the gas. The total amount of sulphur capable of such conversion into sulphuretted hydrogen was 0.07 per cent of the wet mud. The aqueous extract obtained by treating five grams of the mud with 15 c. c. of water, gave no indication of nitrates by the sulphate-of-iron test. The dry material lost, on ignition, 1.67 per cent, and contained 0.17 per cent of nitrogen.

Summary of Results.

	No. 20.	No. 21.
Water,	16.83 per cent,	14.79 per cent.
Coarse sand and pebbles,	16.15 "	28.18 "
Fine sand and clay,	67.02 "	57.03 "
	100.00 "	100.00 "

The specimens dried at 212° F., contained,—

Nitrogen,	0.15 per cent,	0.17 per cent.
Other organic and volatile matter,	1.24 "	1.50 "
Sulphur,	Trace,	0.08 "
Other inorganic matter,	98.61 per cent,	98.25 "
	100.00 "	100.00 "

The amount of chlorine was found to be in No. 20, 0.0022 per cent, and in No. 21, 0.0019 per cent. Some of the above results are expressed in kilograms of the substance in one cubic meter of soil, —

	No. 20. Kilograms.	No. 21. Kilograms.
Water,	340.0	309.0
Nitrogen,	2.5	3.0
Other organic and volatile matter,	20.9	26.7
Sulphur,	–	1.5
Other inorganic matter,	1,656.6[1]	1,749.8[2]
One cubic meter of mud weighed,	2,020.0	2,090.0

[1] Including 0.036 kilos. chlorine. [2] Including 0.034 kilos. chlorine.

I also made a number of unsatisfactory attempts to obtain in some way indications of the amount of soluble organic matter in the soils. The only results which I consider worth repeating are the following. Five grams of the dried material were taken; and the matter soluble in water was extracted by percolation, using in all 150 c. c. of water. The extract thus obtained, treated by Wancklyn's method, gave, —

	No. 20. Grams.	No. 21. Grams.
Ammonia, ...	0.000032	0.000088
"Albuminoid Ammonia," . . .	0.000098	0.00011

Or expressed as above in kilograms to the cubic meter of the original mud, we should have, —

Ammonia, ...	0.011	0.031
"Albuminoid Ammonia," . . .	0.033	0.039

Yours, respectfully,

WM. RIPLEY NICHOLS.

It must be said that the evidence furnished thus far is chiefly negative as regards the reference of the origin and spread of diphtheria, in different localities, directly to particular insanitary surroundings. The condition of the city is such, however, that it would be natural to expect that any "zymotic" disease, when once established, would remain endemic for some time, and would be attended with a high rate of mortality. This is precisely what has occurred in Gloucester, where the mortality from diphtheria (the estimate being based on the number of cases) has been fifty per cent greater than in Lynn, Lowell, Salem, and Taunton; although it is only fair to say that even this high death-rate has been much exceeded in epidemics *of short duration* in some of our country towns.

Abundant testimony has been given as to the contagious and infectious nature of the disease; and that fact is now so well established that it is hardly worth while to multiply illustrations. A single case, however, is in so many ways instructive, that it should be mentioned. A girl convalescing from a mild attack of diphtheria visited a woman who had lately been confined. The infant, two weeks old, and the mother, both contracted the disease, and died in a few days. It seemed possible to exclude all other sources of contagion.

An "epidemic influence," of the nature of which we at present know very little, contagion and infection, and probably some local miasm, dependent, partly at least, upon the dampness of the subsoil, and presumably also upon its polluted condition, perhaps, too, in a general way, upon the unsatisfactory state of the water-supply, — are the three factors which seem to have been most potent in the causation and prolonged duration of the epidemic of diphtheria in Gloucester.

The naturally salubrious character of the place, and the hardiness of health of the inhabitants, have apparently been sufficient to prevent such a degree of virulence in the epidemic as we might naturally have expected.

As the epidemic is apparently at an end, and as the second and third factors mentioned above are as potent as ever, we are led to suppose that the "epidemic influence," whatever that is, has ceased, or that nearly all the susceptible people who have been exposed to the disease have had it; so that the fire may have died out for want of more fuel.

Typhoid-Fever in Taunton and Raynham.

A few severe cases of typhoid-fever at a dairy-farm in Raynham, and the occurrence of the disease in Taunton, a neighboring city, containing an estimated population of twenty thousand inhabitants, caused quite a panic, arising from a fear that the milk might be contaminated, and so have caused the fever. At the request of the selectmen of Raynham, the Secretary of the State Board of Health made an inspection, and reported to them briefly as follows: —

The facts of the case are briefly these: A young man visiting Providence daily, where there were cases of typhoid-fever, became ill with that disease Feb. 16. A sister became ill with the same disease March 9, a hostler March 12, the father March 13, and a maid about the same date. From that time to the time of examination, there had been, in the practice of the leading physicians of Taunton, nineteen cases, including two in which the attending physicians thought there might be some doubt as to the real character of the disease. Of these nineteen cases, there was only one fatal; that is to say, the epidemic in Taunton, if indeed it could be called an epidemic at all, was an exceedingly mild one.

The number of cases, too, was not large, when we consider that they followed an unusually heavy rain-fall, preceded by an uncommonly long drought; that in every undoubted case, well-water,

with the exception *possibly* of two cases in which information was got second-hand, there was every opportunity for the wells to become contaminated by washings caused by the heavy rains; that there are always cases of typhoid-fever in Taunton at this season of the year, and that some of the most experienced physicians think that there have been no more this year than usual, if as many.

The cases of typhoid-fever in Taunton can be explained by ordinary causes, which are more or less present at all times in a city which has been occupied for many years, and where a considerable portion of the people depend upon surface-wells for their water-supplies. An inspection of the dairy-farm revealed the following facts: The stable is in fair order; the cows are in a very good condition; the well from which they are supplied with water is contaminated, but not more so than many wells used by human beings for domestic purposes. None of the cows have been in any way ill. There is no ground for supposing that the cows may be so affected by any thing they eat or drink as to convey typhoid-fever in their milk; although it is well known that the taste of certain vegetables and weeds may be imparted to the milk. If the cows were themselves sick, or if they had eaten certain articles of food, it is conceivable that their milk might cause some disturbance of the bowels in those persons partaking of it; but authentic cases have not occurred where specific diseases, like typhoid-fever, have been conveyed in that way. A large family with four children, living close to this stable, used this milk very freely, and even drank water from the same well with the cows, while all remained well. The milk taken from one of the cans was found to contain no organic impurity.

The hog-distemper, the manuring of the various plots of land with various substances, and the digging out of the little pond in the yard, occurred too early to have any thing to do with the causes of typhoid-fever. In fact, it is quite probable that the first case was imported from Providence.

It remains to be seen whether the milk could be contaminated in any other way. The cans were usually washed more than a mile from the house where the cases occurred, although occasionally with the cistern-water of the house. This cistern is in the cellar, about ten feet from the privy vault. Specimens of water from it, and of the filtered water through the pump, were submitted to a very careful analysis at the Massachusetts Institute of Technology by Professor W. Ripley Nichols. The results of the analysis are as follows: The unfiltered cistern-water and the filtered contained equal amounts of organic impurity. Although the water

is not desirable for drinking-purposes, the small amount of nitrates and of chlorine led Professor Nichols and myself both to the same opinion, independent of each other, that there is probably no contamination whatever of the cistern by the vault. Of course we are aware that we cannot detect or measure "germs" of disease; but, if there were enough leakage in the vault and cistern to allow "germs" of disease to pass through, some of the human filth would probably also have passed through, and that would have been detected. The level of water in the cistern, too, is some five feet above that of the vault; so that, even if there were holes in the walls, the cistern-water would have flowed out, and not the privy filth in.

It is hardly possible, therefore, that the cistern-water could contain "germs" of typhoid-fever, and that the milk could have been contaminated from that source, even if the cans had been washed there every day. The evidence compels one to the conclusion that the milk was pure. Of the four or five hundred persons in Taunton supplied with this milk, only seven had typhoid-fever, and every one of these drank water from surface-wells. So small a result would be simply impossible, if there were any general contamination of the milk. Besides, the milk was sweet-smelling, and free from sediment, after standing a long while: that would not have been the case if it contained impurity from contaminated water. The milk was not at any time so exposed that it could have received "germs," &c., floating in the air of the house.

It remains to be seen whether the first cases of typhoid-fever at the dairy-farm can be explained. The drinking-water, as we have seen, although not satisfactory, was not suspicious, so far as human filth is concerned. The excretions of the patients were thrown into the common vault; and the washings from the infected clothes were thrown into a cesspool, which had direct communication with the house, without traps. The disease is also thought by some good authorities to be, to a certain degree, directly contagious. The cases occurred at a season of the year when the doors and windows are kept closed, thereby concentrating the poison. Of the five persons living in the house, four had the disease. The hostler, who was also exposed while taking his meals in the house, also contracted the disease. The case seems a perfectly plain one, when all the facts are known.

Polluted Wells in Taunton.

A whole family in Taunton was poisoned in severe form by well-water containing one-tenth of a grain of lead to the gallon: the

water was found also to contain in two specimens, in parts per 100,000: —

	Filtered Water.		Chlorine.
	Ammonia.	"Albuminoid Ammonia."	
No. 1, ...	0.0469	0.0077	3.7
No. 2, ...	0.0244	0.0013	3.7

The privy, although with a cemented vault, is only forty feet distant from the well, and is used by several families; considering the absence of other sources of contamination, the large amounts of ammonia and chlorine are probably due to oxidized excrement.

Another well in Taunton, very much used by children in the basement of the Cohannett school, about thirty-five feet from the privies, contained in parts per 100,000, including a considerable amount of sulphate of lime, some carbonate of lime and magnesia and a small amount of nitrates; ammonia, 0.0341 parts; albuminoid ammonia, 0.0133 parts; inorganic matter, 33.5; loss on ignition, 3.0; chlorine, 2.5. In this case, the large amount of albuminoid ammonia, with the increased quantity of ammonia, chlorine, and nitrates, indicates contamination with excrement, as excrement, besides some which has been oxidized. Its use was condemned; and, in view of the fact of the prevalence of diphtheria in Taunton, it is not unlikely that this water is to be held partly accountable, at least for some of the cases.

Typhoid-Fever in Saugus Centre.

The occurrence of a number of cases of typhoid-fever in this village, occupied, as it is, almost entirely by intelligent people, who take care to prevent any evils that may arise from preventable causes, led Mr. Hull and Dr. Francois to request the State Board of Health to examine the well-water, which indeed had been suspected by them. Saugus Centre has a population of about one thousand people, scattered over a large area: it is mostly on elevated, dry, gravelly soil, but in a basin formed by neighboring hills.

The health of the town is generally good. Epidemics are usually mild. In 1876 about seventy cases of diphtheria were reported, of which five were attended with fatal results. In that year there

were three cases of typhoid-fever, with two deaths, in a house very badly drained.

The cases of typhoid-fever in 1877, of which none were fatal, occurred in August and September. The notes of the localities are as follows: —

1. Three adults living in the house. The daughter had a long but not severe illness. The well is sixteen feet deep, lying near a ledge of rock. In the summer the water had a bad taste, which disappeared after prolonged pumping. The privy, thirty feet distant from the well, is emptied once a year. The sink-spout is about fifty feet distant. Chemical examination shows a trace of contamination of the well-water.

2. Three adults live in the house, of whom one had typhoid-fever. The well is ten feet from the privy, twenty-five feet from the sink-spout and on lower ground. The drinking-water shows, by chemical examination, a considerable amount of contamination, which was chiefly in an oxidized form.

A family of six, living higher up the hill, used water from the above well when their own was dry; but the occurrence of the case of fever led them to give it up. Within a week, however, two of the occupants of the house had typhoid-fever, and a third had a milder attack about the same time, its exact period of attack not being definitely settled. Their own well could hardly have been contaminated, as it was so protected. The privy was a hundred and fifty feet distant, the sink-spout two hundred and fifty feet off, and both were carefully attended to.

3. Four people lived in the house, of whom two had the fever. They got their water from a neighboring well, about a hundred feet distant from one privy and a hundred and twenty feet from another. There were no cases of typhoid in the second house. The water shows some contamination, although not excessive.

4. Five people lived in the house, of whom two had feverish symptoms, of which only one could have been positively said to be typhoid. The privy is twenty feet from the well; the cesspool for chamber-slops and sink-slops forty feet off. The water is very much polluted with filth.

5. Nine people lived in the house, of whom one, a girl of fourteen, was attacked in severe form. The well is thirty feet from a cesspool, forty feet from a privy, and a hundred feet from a stable. In August the well, lying on a ledge, was nearly dry, and the water had a perceptible taste. The water is not above suspicion.

6. Four persons in the house, of whom one was ill. The well is twenty feet from a foul-smelling full cesspool. The water cannot be said to reveal to the chemist any positive impurity, although

the presence of a trace of nitrates and of a considerable amount of albuminoid ammonia leads one to suspect that at times there might be evident proofs of contamination.

7. From the town-pump, not very badly situated except as to drainage from the street. The water is not pure enough to be satisfactory. No cases of fever were traced to this well; and, indeed, it would be all but impossible to say whether it has caused transient illness or not; but so many persons drink from it that such a result is not at all unlikely.

8. Of five persons in this dwelling, one had the fever. The well is nine feet deep, and quite near several slop-spouts and surface-privies. The water supplies thirty or forty people. It is somewhat contaminated, but not excessively so. It has a disagreeable taste and smell at times. There are often bad smells from the surface-drainage, and from the banks of a neighboring pond when it is low; and the cellars are wet. The people here are said to be "all of the time ailing;" but no typhoid-fever is known to have occurred before in the locality for six years. The well-water is not pure; but, considering its location, it is not possible to say whence the impurity comes.

9. Of four residents, one had fever, thought to be typhoid. The well is a driven one, close to the rear of the house, through gravel fifteen feet, through four feet of clay, and then to water-bearing gravel: two privies are eighteen feet distant, and a wooden sink-spout passes by the well. The water contains a suspicious amount of impurity.

10. Of seven in this family, the father had typhoid-fever, and a boy of six years obscure febrile symptoms. Another family of seven or eight used the same drinking-water, and had no illness. The well is between two cesspools made of barrels, one eight feet distant, and the other twice as remote: the privy was a hundred and fifty feet off, and the stable half as far. The water is the worst of those examined.

11. Of three persons living in this house, one adult was ill with typhoid-fever. The well-water was not examined. It was seventy feet from a sink-spout and privy. In the tenement-house, of forty or fifty people who used the same water, no case of fever occurred.

12. Of two families of three and four respectively, one adult had the fever. The privy is forty-five feet from the well. The water had a disagreeable taste in the summer.

The following analyses by Professor Nichols refer to the numbers as given above: —

Table of Examination of Water received from Saugus.

[Results expressed in Parts in 100,000.]

Date.	LOCALITY.	Unfiltered Water.		Solid Residue.			
		Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."	Total at 212° F.	Chlorine.
Oct. 26,	No. 1, .	0.0008	0.0021	5.8	1.5	7.3	1.15[1]
"	" 2, .	0.0019	0.0024	16.3	4.7	21.0	3.05[3]
"	" 3, .	0.0048	0.0075	15.2	3.9	19.1	2.90[2]
"	" 4, .	0.0512	0.0115	22.7	2.5	25.2	3.04[3]
"	" 5, .	0.0011	0.0059	16.6	2.7	19.3	3.23[1]
"	" 6, .	0.0021	0.0072	6.0	2.0	8.0	0.52[1]
Nov. 9,	" 7, .	0.0053	0.0064	10.2	5.3	15.5	2.13[2]
"	" 8, .	0.0056	0.0061	22.3	2.7	25.0	3.07[2]
"	" 9, .	0.0075	0.0088	9.4	1.3	10.7	1.68[1]
"	" 10, .	0.0069	0.0123	28.4	3.1	31.5	6.44[3]

[1] Very faint test for nitrates in unconcentrated water by ferrous-sulphate.
[2] Fair test for nitrates in unconcentrated water by ferrous-sulphate.
[3] Very good test for nitrates in unconcentrated water by ferrous-sulphate.

The ten wells examined are probably fair samples of most of those in the town. That is, there is a risk of pollution to nearly all of them ; and this may be greater or less at different times. At the time of examination, the impurity must have been less than when the water was very low, and when the fever prevailed, a few weeks earlier. This examination does not show that drinking polluted water, to the degree existing in Saugus, is attended with certain illness ; but it appears to prove that there is a risk in so doing, and that it is not possible to say what particular tumblerful contains the dangerous element, or what person is susceptible to its influence. It shows clearly that the ordinary distance from privy to well, with the yearly emptying of the former, is such as to at least bring up unpleasant associations to persons drinking the water.

From the point of view of Pettenkofer and other German sanitarians, that typhoid-fever is usually due to emanations from a polluted soil, the above analysis shows how far such pollution may extend, and how extensively the soil must be contaminated in the vicinity of privies, &c.

Diphtheria in Taunton in 1877.

Reported by A. S. Deane, M.D.

Diphtheria has prevailed extensively in Taunton [1] during the past year. Reports of 527 cases have been obtained: of these ninety-three were fatal, or eighteen per cent of the whole. If the percentage of fatality was the same in the practice of physicians from whom no reports were received, the total number of deaths from diphtheria registered in the city clerk's office being ninety-seven, the whole number of cases for the year may be assumed to be about 550. Cases not coming to the notice of any physician, and which have not been reported as diphtheria by the undertakers, have undoubtedly occurred, but not in sufficient number to materially change the statistics given, or to invalidate in the least the conclusions.

As may be observed from the table below, the disease prevailed sporadically until midsummer, when it assumed the form of an epidemic, increasing until October, and declining in December.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
19	10	13	10	1	3	8	57	90	161	94	48	527
3	–	–	5	–	–	5	11	22	31	12	4	93 deaths.

The accompanying map of Taunton, opposite page 496, shows the fact that diphtheria has visited nearly every quarter of the city; yet in certain sections it has been especially prevalent or fatal. The localities in which non-fatal cases have been reported are indicated, as nearly as possible, by dots; fatal cases being distinguished by small crosses.

The following table gives the more important facts with reference to the prevalence and fatality of the disease; it being assumed that the population has not essentially changed since the census of 1875.

[1] The writer desires to express his acknowledgments to the physicians of Taunton, who have kindly furnished him with notes of their cases.

WARD.	Population.	Cases reported.	Deaths reported.	No. of Cases to 1,000 persons living.	No. of Deaths to 1,000 persons living.	Per Cent of Deaths to Cases.
I., .	3,497	98	11	28.024	3.146	11.2
II., .	1,569	13	1	8.286	0.636	7.7
III., .	3.089	132	33	42.732	10.683	25.0
IV., .	1,832	50	10	27.281	5.456	20.0
V., .	1,836	24	3	13.072	1.634	12.5
VI., .	2,286	33	2	14.431	0.875	6.1
VII., .	1,885	33	6	17.665	3.212	18.2
VIII., .	4,434	144	27	32.498	6.087	18.7
	20,429	527	93	25.796	4.552	17.6

In ward 1, where the epidemic was severely felt, the surface near Friend Street is low and wet: much of the land has been reclaimed from woods and swamps within a few years, and the entire ward is in urgent need of drainage. The hygienic surroundings are decidedly bad. In Oak Street, from which a considerable number of cases are reported, the surface is higher, and has a subsoil of gravel. The house-drainage is upon the surface or into cesspools. The prevalence of the disease, however, in this locality, may be clearly traced to the insanitary condition of the dwellings where cases occurred.

Very few cases, comparatively speaking, have been reported from ward 2, although the sanitary conditions are about the same as in other parts of the city where diphtheria was prevalent. A reference to the map will show that this ward is bounded on the east by Mill River, the grounds of the State Hospital for the insane being situated in the upper portion: the gas-works will also be observed as situated in about the centre of the ward. No case was reported from this neighborhood. There is a sewer in Harrison Street, in a portion of High and in Weir Street: otherwise there is no other than surface-drainage.

In ward 3, a densely populated section, there were many cases reported. The surface of this ward is flat, and is undrained, except by the sewer in Main Street and in Broadway to Pleasant Street. One or two sluggish brooks constitute imperfect sewers, but add, if possible, to the insanitary condition of the ward. It will be noticed, by referring to the map, that in Park Street the epidemic was severe, and the fatality larger than in any other quarter; amounting, in fact, to fifty per cent of all cases reported. It may be observed, that, previous to the outbreak of the disease, the pond which is in the immediate vicinity was drawn upon to such an extent that the mud was exposed, from which a noticeably unpleasant

and fetid odor was emitted. The river from Whittenton Mills down is used as a sewer; the water-closets for the use of the mill operatives are directly over the running stream; and the privies of dwellings are numerous on or over its banks, all down its course through the ward. The sewage of the State Hospital also pollutes the stream. Owing to numerous dams, the *débris* of this sewage must exist in large quantities in the bed of the river when the current is sluggish or interrupted. The unsatisfactory condition of this river unquestionably adds greatly to the unhealthy character of the section.

Parallel with, and near Grove Street on the east, is a low, wet quarter, in urgent need of drainage. It was in this locality that the disease first assumed the character of an epidemic.

As in other sections where the disease has prevailed, the hygienic condition of the dwellings was found to be any thing but satisfactory. When improper or insufficient food, foul air engendered from crowded dwellings, from cesspools, from cellars containing vegetable refuse, or from night-soil deposits, — when these were not factors contributing largely to the development of the disease, it could be associated with the presence of polluted wells, by defects in house-drainage, or by direct contact with infected persons.

Ward 4 is a clayey section, the west portion of which is densely populated. It is without sewerage. A group of cases occurred in in April, on Somerset Avenue, which were generally considered to be the result of the private sewage from Webster Street, which had entered the gutter beside the railroad-bed, and was found accumulated at the street-crossing: this accumulation was removed by the board of health, and the disease made no further headway. In Grant Street, a fatal case occurred in January: the immediate locality is low and wet.

But few cases were reported from ward 5. It is an outlying ward, containing the village of East Taunton. There were cases reported from Hood Street, near the river, where, as usual, the hygienic surroundings were unfavorable.

Neither was the disease generally active in ward 6, and it proved fatal in but one or two cases; yet this is a thickly populated section, the sanitary conditions of which are not better or more favorable than of other quarters where the disease has raged with the greatest virulence. There is only surface-drainage: the river is acted upon by the tides, and the surface of the ward slopes from Somerset Avenue to the wharves.

In ward 7 thirty-one cases were reported. Twenty-two of these were from Westville, a small factory village on Winthrop Street, two or three miles distant. These occurred among the mill opera-

tives. The sanitary condition of the village is fair, the privies are about one hundred feet from the common well, and the vaults are regularly cleaned twice yearly. Cesspools receive the house drainage; cellars in a fair condition. In Clifford Street, where there were fatal cases, the surface is dry, but in close proximity to swamps.

In ward 8 the epidemic was spread over a wide area. In the locality of Washington Street, near Cherry Street, there were many cases, attended with considerable fatality. The tract is a plain of moderate elevation, has a sandy soil, and is undrained. The same natural conditions exist in the neighborhood of Bay Street, near Britannia Street, where there were many fatal cases. The population of this quarter is chiefly operatives working in Hopewell Cotton Mills, or in the Silver Plating and Britannia Factory. In Cottage Street, where there were fatal cases, the land is low and wet, near to a bog on the one side and a pond on the other; the wells are shallow, and are situated far too near cesspools and privy-vaults.

Near Whittenton Mills, among those employed in the factory, the disease was particularly severe, with a large percentage of fatal cases. In Second Avenue the surface is low, and near the pond the cellars are damp, and the water-supply poor, taken from a well situated only thirty feet from privies: the drainage is through stone drains into the pond. Above this quarter, a little further, the land is high and well drained, although the water-supply is very poor, the wells being scarcely fifteen feet from privy vaults: these, however, were often cleaned and disinfected, the corporation taking good care of the sanitary condition of the locality.

The whole city is pretty uniformly flat and wet, lying in low, alluvial soil, which is undrained, and which receives a large amount of water from water-closets, &c., since the city has introduced a public supply of water, without at the same time furnishing sewers. From Winthrop Street, through wards 4 and 6, the soil is chiefly clay; near High Street, in ward 2, there is an elevation, but the ground is still wet; there is also a hill of sand or gravel about the cemetery, in ward 1. Ward 8, and that portion of Ward 3 as far as Adams and George streets, are sandy; the rest of Ward 3 is low and quite wet.

The character of diphtheria, as it has been observed in Taunton during the past year, is that of a specific disease, running its course in from eight to fourteen days, generally characterized by considerable constitutional disturbance, and a spreading inflammation of the mouth and the neighboring lymphatic glands, attended with a white membraneous exudation upon the tonsils and parts adjacent. Death generally occurs from exhaustion, or from difficult

respiration, owing to an extension of the morbid process into the larynx, and occasionally from paralysis. Recoveries are tedious, on account of the debility and exhaustion incurred, and in consequence of painful sequelæ, as albuminuria and paralysis.

The distinction between diphtheria and croup has been in most instances well pronounced, and no difficulty has been experienced in distinguishing between them. In Shepard Street, however, a case occurred in April, where a child was attacked with what appeared to be croup, no exudation in the throat being seen, and no case of diphtheria having occurred in the neighborhood; yet in two weeks a second child was stricken with unmistakable diphtheria, this case marking the commencement of the epidemic in the third ward. Undoubtedly a few cases have been returned as croup, when the primary cause was diphtheria; the disease having extended into the larynx, constituting to all appearances croup.

The evidences of the contagious nature of diphtheria have been numerous, and established beyond question. It is admitted, however, as in the case of other zymotic affections, that the source and nature of its own specific virus, miasm, or contagion, is undiscovered.

In a house on Oak Street, when the disease manifested itself in malignant form, the three children yielding to its virulence, relatives and acquaintances of the family, children, residing some miles from any infected locality, contracted the disease, although they were in the house but a few hours.

Scarcely any cases are reported as consequent upon association at the public schools, the superintendent and other officials taking precautions to prevent contact with infected persons by excluding convalescents until furnished with a certificate from the attending physician.

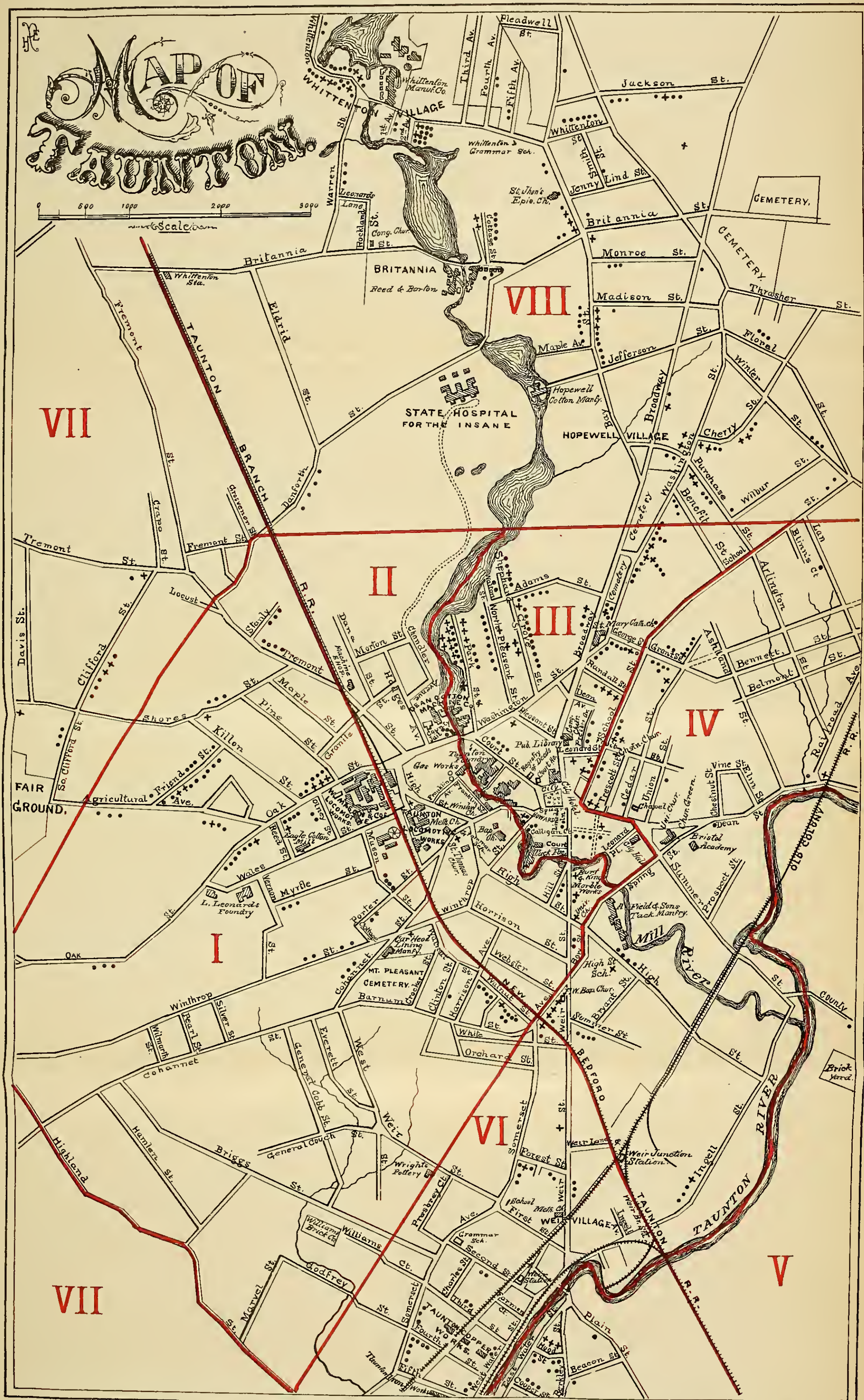
When the disease made its appearance in a family, there have been numerous cases where nearly every member has suffered in a degree, some more, some less, the younger members being the first to yield to its insidious approaches. Persons acting in the capacity of nurses, and those in close contact with the sick, often became infected with the disease.

The following is the record of deaths in respect to age; which plainly shows that the fatality was largely among children of tender years.

From 1 to 3 years of age,	39
4 to 6 " "	33
7 to 10 " "	15

. 1
. 1
. 1
. 1
. 1
. 1

ion of
curred,



THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON

Of 12 years of age,	1
13 " "	1
16 " "	1
18 " "	1
19 " "	1
36 " "	1

The following table gives the results of a sanitary inspection of the houses where seventy-five of the cases of diphtheria occurred, taken in order, as they were treated.

Seventy-five Cases of Diphtheria

No. of Family.	Street.	Nationality.	Occupation of the head of the Family.	No. of Patient.	Age.	Date of Sickness.	Character of the Disease.	Soil.	External Surroundings.
1	Mason, .	Am., .	Shoemaker,	1	35	Jan., .	M.	Low, wet, .	Near low, wet, undrained land,
				2	12	Nov., .	M.	–	
2	Danforth, .	Am., .	–	3	6	Jan., .	M.	Low and wet,	
				4	11	Jan., .	M.		
3	Danforth, .	Am., .	Carpenter, .	5	4	Mar., .	M.	Low and wet, .	
4	Fifth Av'e, .	Eng., .	Operative, .	6	4	Apr., .	M.	Dry, . .	Favorable, .
				7	2	Apr., .	M.	–	
5	School, .	Irish, .	Washerwoman.	8	8	Mar., .	S.	Wet, . .	Neighboring yards filthy,
				9	10	Mar., .	F.	No drainage,	
6	Washington,	Am., .	Servant, .	10	20	Apr., .	M.	Dry, . .	Ordinary, .
7	School, .	Irish, .	Laborer, .	11	2	Mar., .	F.	Wet, . .	Insanitary, .
8	Shepard, .	Irish, .	Laborer, .	12	7	May, .	F.	Wet, of clay,	Bad, p'd near, vicinity night-soil pits,
				13	6	June, .	M.	No drainage,	
9	Oak, . .	Am., .	Laborer, .	14	9	Aug.,	F.	Dry, but not drained,	
				15	3	Aug.,	F.		Favorable, .
				16	2	Aug.,	F.		–
				17	28	Aug.,	M.		
10	Oak, . .	Irish, .	Washerwoman,	18	5	Aug.,	M.		Fair, . .
				19	7	Aug.,	M.		
11	Cherry, .	Eng., .	Operative, .	20	2	Aug.,	F.	Sandy, . .	Vicin. of n'g't-soil deposits, stagnant pool front of door,
				21	30	Aug.,	S.	Sandy, . .	
12	Grove, . .	–	–	22	6	Aug.,	S.	Wet, . .	Night-soil deposits near,
13	Madison, .	Am., .	Washerwoman,	23	15	Aug.,	S.	Dry, . .	Fair, . .
14	Purchase, .	Eng., .	Laborer, .	24	5	Sept.,	M.	–	
				25	3	Sept.,	S.	Dry, not drained,	Insanitary, .
				26	2	Sept.,	S.		
				27	1	Sept.,	M.	–	
15	Olney, . .	Irish, .	Laborer, .	28	8	Sept.,	M.	Wet, . .	Insanitary, .
16	Whittenton,	Eng., .	Operative, .	29	6	Sept.,	S.	–	Near stables, pig-pens, and night-soil deposits, near low, wet land,
				30	4	Sept.,	S.	Dry, . .	
				31	9	Sept.,	M.	–	
17	Oak, . .	Irish, .	Laborer, .	32	18	Sept.,	M.	Dry, . .	Fair, . .

occurring in Taunton in 1877.

House Drainage.	Condition of Cellar.	Water Supply.	Privies, Cesspools, &c.	Garbage.	Remarks.
Into cesspool,	Not clean,	Well, near source of pollution.	Privies not often cleaned,	Partially removed,	Scarlet fever in the family.
Upon the surface,	Not clean,	Shallow well.	Privy in fair condition,	Partially removed.	
Into cesspool,	–	Well near cesspool.	Privy clean,	Fed to pig.	
Into privy,	Damp,	Well, thirty ft. from privies.	Privy not clean, bad odor,	–	Sewer-gas in house.
Surface,	Wet,	Well, very near cesspools.	Privy not clean,	Thrown into yard.	
Drainage on surface,	Damp,	Well,	Privy not clean,	Thrown into yard.	
	Wet, filthy,	Well near cesspool.	Privy not clean,	Thrown into yard,	Near case 8, or 18 and 9.
Into a cesspool,	Very wet, not ventilated,	Well, near privy.	Privy not clean,	Partially removed.	
		–	–	–	Bad odor from sink.
On the surface,	Very filthy,	Well 15 feet from privy.	Privy far removed,	Thrown out,	House small, and very filthy.
–	–	–	–	–	Previous sickness in the family.
On the surface,	–	Well, 15 feet from the privy.	Away from the house,	Thrown into the yard,	Other cases in same house.
Upon the surface,	Damp,	Well,	Not clean,	Thrown out,	A fatal case of "croup," so called, had just occurred in family.
	Damp,	Well, near privy.	Not clean,	Partially removed,	
	Damp,	Well,	Clean,	Partially removed,	Living in a basement.
Into imperfect cesspools,	Damp,	Well,	Not clean,	Fed to pigs,	(?) Contracted the disease at a neighbor's.
On the surface,	Damp,	Well,	Not clean,	Thrown behind the house.	
Into private sewer,	Damp,	Well 15 feet from privy.	Cleaned once or twice a year,	Removed.	
On surface,	Damp,	Well, near privy.	Clean,	Thrown into privy.	

Seventy-five Cases of Diphtheria occurring

No. of Family.	Street.	Nationality.	Occupation of the head of the Family.	No. of Patient.	Age.	Date of Sickness.	Character of the Disease.	Soil.	External Surroundings.
13	Park, . .	Irish, .	Laborer, .	33	4	Sept.,	F.	Wet, no drainage,	Ins'tary, garbage in neighbor's yard,
				34	2	Oct., .	F.		
19	Washington,	Irish, .	Laborer, .	35	4	Oct., .	S.	Dry, no drainage,	
				36	2	Oct., .	S.		Fair, . . .
20	Beacon, .	Irish, .	Painter, .	37	7	Oct., .	S.	Dry, . .	Fair, . . .
21	Bay, near Britannia,	Am., .	Laborer, .	38	7	Oct., .	F.	Dry, . .	-
			-	39	3	Oct., .	F.	-	House old, cesspools under window emit a bad odor,
				40	2	Oct., .	S.	-	
				41	11	Nov., .	F.	-	
22	Whittenton,	Am., .	-	42	7	Sept.,	F.	High and dry,	Ponds, & low, wet land in vicinity.[1]
				43	3	Sept.,	F.		
				44	45	Oct., .	S.		
				45	17	Oct., .	M.		
23	Second Ave.,	Irish, .	Operative, .	46	16	Oct., .	M.	Wet, near pond,	Pond, & low, wet land in vicinity,
				47	2	Oct., .	M.		
24	Cedar, . .	Irish, .	Laborer, .	48	3	Oct., .	M.	Wet, . .	Soil filthy from house drainage,
25	Bay, near Hopewell,	Am., .	Britannia worker,	49	4	Oct., .	S.	Dry, except near well,	-
				50	6	Oct., .	S.		Fair, . . .
				51	10	Nov., .	M.		-
26	Washington,	Irish, .	-	52	7	Oct., .	M.	Dry, undrained,	Unfavorable, .
				53	3	Oct., .	M.		-
27	Bay, near Munroe,	Eng., .	Chaser, .	54	3	Sept.,	F.	Dry, . .	Near night-soil deposits,
28	Jackson, .	Am., .	Operative, .	55	7	Oct., .	F.	Wet, . .	Near night-soil deposits,
29	Bay, near Britannia,	Am., .	Mechanic, .	56	6	Oct., .	M.	Dry, not drained,	Near night-soil deposits,
				57	15	Oct., .	M.		Soil soak'd with house drainage, Swine kept near house,
30	Bay, near Britannia,	Eng., .	Operative, .	58	9	Oct., .	S.	Wet, .	
31	Grant, . .	Am., .	Watchman, .	59	6	Oct., .	F.	Wet, . .	Priv's and pig-pen near house,
				60	9	Oct., .	S.	-	
32	First Ave., .	Am., .	Teamster, .	61	30	Nov., .	M.	Wet, . .	Near ponds, and low, wet land,
33	Grove, . .	Irish, .	Railroad employé,	62	9	Nov., .	S.	Wet, . .	Near night-soil deposits, and low, wet land,
				63	39	Nov., .	S.		
34	N. Pleasant,	Irish, .	Laborer, .	64	1	Oct., .	F.	Dry, . .	Near pond and night-soil dep'ts,
				65	5	Oct., .	S.	-	-
				66	7	Oct., .	S.	-	-
				67	9	Oct., .	S.	-	-

[1] Night-soil pits near by; cove of made-land in front of house.

in Taunton in 1877. — Continued.

House Drainage.	Condition of Cellar.	Water Supply.	Privies, Cesspools, &c.	Garbage.	Remarks.
Into cesspool,	Damp, . .	Well, near cesspool,	On the river-bank,	Partially removed,	Other fatal cases in the family, and in adjoining premises.
On surface, .	Damp, . .	Well, within a few ft. of privy,	Open vault, not clean,	Not removed.	Fam'y oc'py basement; scarlatina in next house.
Into cesspool,	Damp, . .	Well, . .	Clean, . .	Removed,	
Into cesspool,	-	Well, . .	Not often cleaned,	-	Children poorly nourished.
Into priv. sewer to pond,	Good, . .	City supply, .	Privy 30 feet from house, clean,	Removed, .	Disease thought to have been contracted from a case near by.
Into sew'r to pond,	Damp, not ventilated.	Well, 30 feet from privy,	Privy in fair condition,	Removed, .	Other fatal cases had recently occurred in family.
	Damp, not ventilated.				
On surface, .	No cellar, .	Well, .	Privy 5 ft. from back door, not often cleaned,	Thrown out.	
Through pipe into cesspool,	-	Well, evidently contaminated by cesspool leakage,	In fair condition,	Removed, .	Other cases occur'd in this bl'k, the water supply being from the same well.
	Damp, . .				
On the surface by op'n spout	Damp, . .	Well, near cesspool,	Not often cleaned,	Thrown in yard.	
In cesspool, .	Damp, . .	Well, near privy,	Not often cleaned,	Removed.	
In cesspool, .	Damp, . .	Well, near privy,	Not clean, .	Removed.	
In cesspool, .	Damp, . .	Well, in front of house,	In fair condition,	Removed, .	Cases of the disease in the next house.
Thro' spout, on the surf,	Damp, . .	Well, near privy,	In fair condition,	Fed to pigs, .	Cases of the disease in the next house.
Into cesspool,	Damp, . .	Well, . .	Not often cleaned,	Partially removed.	
Into drains entering vaults.	Damp, . .	Well, 30 feet from privy,	Clean, . .	Partially removed.	
Into private sewer,	Damp, not clean,	Well, . .	Not clean, .	Partially removed,	Some evidence of the disease being contracted from a schoolmate.
Through wooden spout into cesspool,	Damp, . .	Well, . .	Vault, not clean,	Partially removed,	Family poorly nourished, and in unfavorable circumstances.

Seventy-five Cases of Diphtheria occurring

No. of Family.	Street.	Nationality.	Occupation of the head of the Family.	No. of Patient.	Age.	Date of Sickness.	Character of the Disease.	Soil.	External Surroundings.
35	Winthrop, .	Irish, .	Laborer, .	68	3	Dec., .	F.	Near the river,	Adjoining premises unclean,
				69	9	–	S.		
36	Spring, .	Am., .	–	70	9	Dec., .	M.	Wet and clayey,	Near low, wet land,
37	School, .	Am., .	Mechanic, .	71	3	Dec., .	M.	Dry, . .	Near low, wet land,
38	Purchase, .	Am., .	–	72	1	Dec., .	F.	Dry, . .	Good, . . .
39	Purchase, .	Am., .	Laborer, .	73	15	Dec., .	M.	Dry, . .	Fair, . . .
40	Cottage, .	Am., .	Mechanic, .	74	38	Dec., .	M.	Wet, . .	Near pond, and boggy land,
41	Porter, .	Irish, .	Operative, .	75	16	Dec., .	M.	Wet, . .	Near wet land, hygienic surroundings bad,

in Taunton in 1877. — Concluded.

House Drainage.	Condition of Cellar.	Water Supply,	Privies, Cesspools, &c.	Garbage.	Remarks.
Defective, .	Damp, . .	Well, polluted,	Privy over river,	Partially removed.	Family suffering from lead poisoning; in poor circumstances.
Good, . .	Dry, . .	City water, .	Clean, . .	Removed, .	
Into cesspool,	Damp, . .	Well, . .	Clean, . .	Removed, .	Odor in kitchen from cesspool.
Into cesspool,	Damp, . .	Well, . .	Clean, . .	Removed, .	Other cases in the vicinity.
Into cesspool,	Damp, . .	Well, . .	Clean, . .	Removed, .	Other cases in the vicinity.
Into cesspool,	Wet, . .	Well, near cesspool,	Clean, . .	Removed, .	Other cases in the vicinity.
Into shallow cesspool,	Wet, . .	Well, near cesspool and privy,	Not clean, .	Partially removed.	

The condition of the atmosphere has not appeared to exert any marked influence upon the disease.

The foreign element has suffered to a much greater extent than the native population. The greatest number of cases have been found among those poorly or insufficiently clothed and fed; although it is proper to say that there were numerous instances of cases among the opulent, even where every sanitary precaution was observed.

The source of the water-supply has been in nearly every instance a well, which in general would be found to be shallow, and often situated so as to admit surface-water, and so close to vaults and cesspools as to be liable to pollution.

The cellars of infected houses were in many instances filthy from accumulations of dirt and decomposing garbage, or wet and mouldy from want of drainage and ventilation.

Privies were generally so situated as to furnish offensive effluvia, were often in filthy condition, the vaults being simple excavations, rarely cemented or properly closed and ventilated.

The house-drainage has been found, in almost every case, more or less defective. It was either entirely upon the surface, or into cesspools; and kitchen-sinks were far too often imperfectly trapped, thus allowing an escape of sewer-gas, exceedingly deleterious in its effects.

The attention of the community should be especially directed to the paramount importance of improving the sanitary condition of the city; for it appears to be unquestionably possible, by securing better hygienic conditions, to lessen the extent of disease, and to deprive it of much of its severity.

Drainage on a broad and scientific basis; the prompt removal, by a properly constituted force, of accumulated garbage and filth of every description, to a safe distance from densely inhabited quarters; a vigorous enforcement of municipal ordinances bearing upon nuisances; the cementing of privy-vaults and cellars; and a more extended and universal use of the city water, recently introduced, — are a few of the readiest means at our disposal; and we submit that the lesson taught us in the experience of the past year ought not to be thrown away.

INDEX.

ALPHABETICAL INDEX.